INCREASING MOTIVATION BY ADAPTING INTELLIGENT TUTORING INSTRUCTION TO LEARNER ACHIEVEMENT GOALS

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INCREASING MOTIVATION BY ADAPTING INTELLIGENT TUTORING

INSTRUCTION TO LEARNER ACHIEVEMENT GOALS

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To my family – Judith, Joshua, Mom, Dad, Grandma, and Granddad

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ANOVA	Analysis of Variance
AS	Avoidance Statement
BA	Business Administration
BCH	Biochemistry
BIO	Biology
BNI	Brief Negotiation Interview
CM	Computational Media
CQ	Challenge Question
DM	Digital Media
ECON	Economics
ENG	Multiple Engineering Majors
F	Local Variables
G	Global Variables
HCC	Human Centered Computing
HPA	Health Promotion Advocate
IAML	International Affairs and Modern Languages
IL	Intrinsic Learner
IRB	Institutional Review Board
ITS	Intelligent Tutoring System
K-S	Kolmogorov Smirnov
K-W	Kruskal Wallis
MApproach	Mastery Approach

MAvoid	Mastery Avoidance
MEC	Motivationally Enhanced Coach
M-W	Mann-Whitney
PApproach	Performance Approach
PAvoid	Performance Avoidance
PS	Promotional Statement
SBIRT	Screening Brief Intervention &Referral to Treatment
ST	Student’s T-Test
STC	Science Technology and Culture
VBT	Virtual BNI Trainer
VC	Virtual Coach
VP	Virtual Patient

SUMMARY

The impact of affect on learning and performance has caused many researchers in the field of cognitive psychology to acknowledge the value of motivationally supportive instruction. Goal orientation, which refers to the perceptions and behaviors of the learner in achievement situations, has been the most predominant theory in learning motivation. However, research suggests multiple components are responsible for affecting student cognitive engagement. The traditional framework distinguishes individuals who are self-motivated to master challenging tasks from those who are motivated to earn favorable judgments of performance as intrinsic and extrinsic learners, respectively. In addition, learners may be further categorized by an eagerness to ensure a positive outcome or by their vigilance in avoiding negative outcomes. As such, my research explores how these motivational categories can be utilized to construct a more robust instructional model.

The objective of this research is to evaluate the effectiveness of adaptive remediation strategies on motivation and learning performance. Research suggests the cost of integrating cognitive tasks with error analysis outweigh the benefits of sparse learning gains. However, further investigation is required to understand how feedback can improve these outcomes. The experiment presented here seeks to evaluate the adaptive instruction of two pedagogical agents embedded within two separate versions of the Virtual BNI Trainer. The basic coach uses a model of the learner's experience level to determine an appropriate level of elaboration required during remediation. In contrast, the motivationally enhanced coach uses a model of the learner's goal orientation to construct feedback that appeals to their natural disposition.

A controlled experiment was conducted to evaluate the effects of adaptive instruction on student self-efficacy, engagement, and learning performance in the Virtual BNI Training Environment. The results of this experiment are used to establish guidelines for integrating goal orientation, error analysis, and feedback within a virtual coach, to improve motivation and learning performance. In addition, these findings also indicate areas for future research.

CHAPTER 1

INTRODUCTION

Individual tutoring has been considered the most effective means of instruction among educational psychologist (Lepper & Woolverton, 2002, p. 135). By using the representational affordances of computational media, computer-based instruction has created a new pedagogical model based on the one-to-one tutoring strategy. Although successful in the transfer of declarative knowledge, early attempts in the design of intelligent tutoring systems failed to consider student affective and emotional states in the learning process (Lepper & Woolverton, 2002, p. 137). Thus, a movement towards a situated view of human cognition resulted from a necessity of psychologists, designers, and educators to develop a complete understanding of how people learn.

Although one of the main challenges of intelligent tutoring systems is balancing interesting material with an appropriate level of instruction, most research has emphasized the detection of changes in affective states with little concern for student motivation. There are two fundamental problems with this reactive approach: (1) It emphasizes the resulting physical response, as opposed to its environmental cause, and (2) it does not address the issue of different learning motivations. Studies indicate that students who are motivated to learn and believe the work is interesting and important are more cognitively engaged (Dweck C. , 1986, p. 1043). Because educational effectiveness depends on student interest, pedagogical strategies should include student motivation in their design.

My research presents a more proactive approach to motivation, which adapts pedagogical instruction based on a model of the learner's experience level and goal orientation. The objective is to provide a customized learning environment that 1) includes adaptive motivational assistance, 2) persuasive recommendations, and 3) context appropriate feedback. Using the virtual coach (VC) interaction in two versions of the Virtual BNI Trainer (VBT), I will support both designs using elements of learning theory, as well as demonstrate their impact on learning performance and motivation by using a comparative analysis of empirical data.

ITS Background

Intelligent tutoring system (ITS) design has been an ongoing process throughout its history. By studying the evolution of cognitive psychology, we can gain an understanding of its influence on the ITS field. An information-processing view of cognitive science can be viewed as a set of steps in which an "abstract entity" called information is processed (Anderson, 2005, p. 11). Like the behaviorist before them, early cognitive psychologists removed features of human consciousness from cognitive analysis. However, instead of using the method of introspection, they focused on the mind's internal representation. Thus, the goal of cognitive science is to integrate research in psychology, linguistics, neuroscience, and artificial intelligence (AI) to perform logical analysis and simulations of cognitive processes (Anderson, 2005, p. 11).

Advances in computational systems during the 1970's led cognitive scientist to consider computerized instruction as a potentially cost-effective tool for individual tutoring. As a result, during the first wave, ITS systems were developed with a model of the learner as an information-processor. Although they were efficient in the transfer of information and feedback, these systems were unable to provide affective, motivational, or socio-emotional support (Lepper & Woolverton, 2002, p. 137). Therefore, researchers in cognitive psychology and AI began working on the next generation of computer-based training systems (Shute & Psotka, 1996, p. 578).

The central question driving research in artificial intelligence and cognitive psychology was how to make computer systems perform more intelligently. The debate centered on the process of error correction in the design of ITS systems. Initially errors were perceived to originate from the learner's lack of knowledge. From an information processing perspective, these incomplete knowledge structures were viewed as misconceptions resulting from the natural progression from novice to expert. Therefore, it was hypothesized that learning efficiency could be improved by integrating the analysis of knowledge structures within ITS systems (Shute & Psotka, 1996, p. 573). This premise, led to the development of model-tracing technology and bug catalogs, which attempted to diagnose and manage specific errors during computer interaction. However, a second view of errors as a result of insufficient support given to the learner has been widely attributed to the development of more sophisticated ITS systems. As the efficiency of ITS systems increased during the 1980's, general criticisms regarding standardization were subsequently replaced with debates on standards and best practices (Shute & Psotka, 1995, p. 583).

During the 1990's controversy resulted from two different approaches to learning (situated and procedural). Pervasive questions resulted from differences in philosophical views on which environment was more effective for learning. Proponents of situated cognition support the integration of cognitive psychology with emotions and reasoning. In contrast to the procedural approach considered above, situation theorists observe the socio-cultural influence of teachers, students, and the environment in knowledge transmission. Thus, a more contextualized view, in which knowledge is embedded and distributed through a cultural ontogeny, has been considered a better model of learning and instruction. Although these two approaches raised considerable debate during the 1990's, it is now generally accepted that the view of the unaided individual with no access to people or mediating artifacts does not provide an accurate model for learning instruction (Nardi, 1996, p. 69). A brief overview of specific systems can reveal how these systems sought to integrate both philosophies.

Integrated ITS Models

Koedinger and colleagues PUMP Algebra Tutor (PAT) demonstrates that learning performance can be improved when problems are contextualized in real world situations. Although based on Anderson's ACT model, PAT integrates elements of situated cognition into its design. The ACT model allows the tutor to respond with adaptive and topic appropriate assistance. The design anticipates increased performance under conditions which promote "inductive reasoning" (Koedinger & Anderson, 1997, p. 33). Thus, the curriculum is designed around mini-projects that encourage active learning. The cognitive tutor also uses a variety of motivational techniques that encourage student engagement. Initial hinting directs the learner's attention to relevant information. Immediate feedback offers efficiency and alleviates student frustration. The tutor avoids negative feedback, which improves student self-efficacy and affect.

Arthur Graesser and colleague's AutoTutor proves that positive learning gains can be produced by modeling instruction on the strategies of inexperienced human tutors. Although the one-to-one expert tutor model is utilized by many sophisticated ITS systems, AutoTutor implements novice strategies emphasizing discourse and deep reasoning. AutoTutor is a conversational system that instructs college students on computer literacy by using collaborative scaffolding techniques. A disembodied pedagogical agent with synthesized voice grounds the communication by enabling various back channel elements. Hints, prompts, and assertions are used to aid inductive reasoning and reduce student frustration. Agent expressiveness facilitates motivation by using socially acceptable forms of expression that regulate student self efficacy.

Periodic positive feedback acknowledges receipt of communication and increases motivation by alerting the student of his progress.

Fleming and colleague's Virtual Reality (VR) Simulation demonstrates the effectiveness of VR technology in medical training. The VR Simulation provides an experiential learning environment that allows learners to practice screening and intervention skills through novel interactions with a virtual patient (VP). The system includes a patient scenario, which develops through VP correspondence during a routine consultation. Implicit and explicit feedback is provided by the onscreen help agent and VP respectively. The onscreen help agent provides nonverbal cues, while the VP uses verbal and nonverbal cues to indicate learner performance. The interactive agents and additional help button persists onscreen. Motivation is provided via game-based system mechanics, which occur as a result of the learner's patient interaction, professional assessment, and intervention recommendation.

Project Motivation

From its emphasis on rational thought to normative evaluations, educational institutions draw clear differences from the real-world. In fact these institutions have been criticized as an epistemic culture that attempt to reconfigure the world into an artificial subculture. Thus, there is a fundamental disconnect within the educational system, in which abstract thought conflicts with real-world contextualization. The problem is further exacerbated by the existence of multiple teaching strategies, which are based on different philosophical views of human cognition. For instance, if an educator believes that intelligence is innate, he will focus on assisting students reach their full potential. However, if the educator believes that mental capacity is augmented through interaction with the world, then the curriculum will most likely include opportunities for unassisted exploration.

The problem with these different strategies is the assumption that they are universal. However, studies show a significant variance in student performance in different learning environments. Although individualized instruction is not feasible in the traditional classroom, simulated interactive environments are made possible through the affordances of digital media. I believe an adaptive strategy that takes the learner's natural disposition into consideration is a more effective method. In addition, offering the learner more control over their educational experience allows them to take more responsibility for their success as an active participant. Therefore, I advocate an adaptive approach to learning, which is able to identify differences in learning orientation and experience level that can be used to develop customized strategies to assist the learner in reaching their full potential.

I choose to explore this concept in the field of ITS because it provides a more flexible environment that is easily customizable and measurable. The emergence of emotionally supportive ITS systems have reinforced my position that human cognitive development cannot be fully realized nor adequately facilitated through information processing methods alone. Therefore, it is my goal to analyze internally and externally focused learning theories, in order to design a convergent instructional model, which promotes a more accurate view of human cognition. I postulate that such a model will enhance the learning experience by enabling computer-based systems to respond in more intelligent ways.

This research aims to quantify the effects of adaptive instruction on student self-efficacy, engagement, and learning performance. It also seeks to evaluate remediation strategies in terms of learning performance and motivation, by comparing a scaffolded instructional model, based on the learner's experience level, with a motivational model, based on the learner's goal orientation. It hopes to contribute to the intelligent tutoring field by evaluating the effectiveness of cognitive strategies embedded within the feedback of pedagogical agents to increase student motivation.

Design of the Evaluation

Research Questions

1. When should goal oriented feedback be used during remediation?
2. Does goal oriented feedback reduce negative affect (boredom, anxiety)?
3. Are students more receptive to correction when recommendations are goal oriented?
4. Does self-efficacy, engagement, and performance increase as a result of goal orientation?
5. How can errors, goal orientation, and feedback create a customized environment?
6. Do all learners have a dominant goal orientation?
7. What type of feedback is effective for neutral orientations?
8. How often should goal-oriented feedback be delivered, in order to have an effect?
9. How does the type and quantity of errors influence the effectiveness of feedback?
10. How does a learner's goal orientation influence the effectiveness of feedback?

Evaluation Methods

An evaluation method is necessary to verify product quality, in addition to testing and validating hypotheses. Formative and summative evaluations are used respectively to verify the quality of the design and the finished product. Interpretive and empirical methods are two main strategies for gathering data from human participants. Interpretive methods consist of field studies, such as ethnographic studies, which detail observed interactions in the subject's natural environment (Dix, Finlay, Abowd, & Beale, 2004, p. 343). Empirical methods consist of laboratory studies, which allow controlled experimentation and analysis of results (Dix, Finlay, Abowd, & Beale, 2004, p. 358).

Once the type of evaluation has been determined, in addition to the experimental task, the researcher must determine the data gathering method. Simple observations are usually inadequate in determining user opinions; therefore several techniques are available to acquire more detailed information. Verbal protocols, such as think-aloud and co-discovery teams can provide useful insights into user beliefs. However, observations are only as useful as their recording method. Therefore protocol analysis, such as paper and pencil, audio/video recording, and computer logging techniques are available. Surveys and computer logging will be used to gather qualitative and quantitative data respectively, during the evaluation of the VC instructional model. See Table 1 below for guidelines on evaluation methods.

Table 1 Classification of Experimental and Query Techniques

	Experiment	**Interviews**	**Questionnaire**
Stage	Throughout	Throughout	Throughout
Style	Laboratory	Lab/field	Lab/field
Objective?	Yes	No	No
Measure	Quantitative	Qualitative/quant.	Qualitative/quant.
Information	Low/High level	High level	High level
Immediacy	Yes	No	No
Intrusive?	Yes	No	No
Time	High	Low	Low
Equipment	Medium	Low	Low
Expertise	Medium	Low	Low

[Dix, Finlay, Abowd, & Beale, 2004, p. 361]

CHAPTER 2

LITERATURE REVIEW

This chapter will provide a comparative analysis of current theories in the field of cognitive and developmental psychology. By studying the progression of cognitive psychology from its origins in information processing to its postmodern emphasis on socio-cultural context, researchers can gain a more complete understanding of human cognition and determine its implications for education technology. These theories will be presented in terms of arguments from central figures within each discipline. In addition, they will be contrasted with socio-psychological theories of learning and motivation.

Learning Theory

Constructivism

Information processing, which has become the dominant approach in cognitive science, has been very influential in the study of learning and development. Jean Piaget's theory of constructivism uses the internal construction of knowledge in the mind as its unit of cognitive analysis. It suggests that the restructuring of knowledge occurs when individual experience conflicts with preexisting beliefs. The idea that individual reality is internally constructed through exploration was extracted from Piaget's research in "sensorimotor intelligence" (Wadsworth, 1996, p. 54). Thus, Piaget's theory makes a clear distinction between intellectual development, which results from the expansion of cognitive structures through self-regulated adaptation, and education, which emphasizes skill acquisition through direct instruction (Wadsworth, 1996, p. 148).

Constructivism fails to acknowledge the role of ontogeny in individual and cultural development. This view implies that the introduction of optimal strategies may interfere with the development of self-regulation and prevent the learner from developing effective problem solving skills. Thus, it diminishes the significance of socially constituted symbolic representations and the role of cultural transmission in the development of cognitive function (Tomasello, 1999, p. 125). In addition, since cognitive development is believed to occur in stages, development is considered a prerequisite for learning (Wadsworth, 1996, pp. 11, 156). Consequently, its emphasis on the abstract properties of the mind reveals an underlying foundation in information processing theory (Tomasello, 1999, p. 57).

Seymour Papert builds on this theory of mental development through the internalization of action in his theory of constructionism, by emphasizing the importance of creative exploration in self-directed learning. Limitations on mental capacity are eliminated, by enabling refinement of theories and methods through creative exploration and construction of physical objects. Although Papert's use of external tools allows more diverse problem solving methods, its emphasis on the augmentation of mental capacity differentiate it from more contemporary situational theorist (Constructionist Learning, 2010). Papert uses the construction of tangible artifacts to ground social interaction. Thus, Papert's research focuses more on the process of mental construction once an individual is stretched beyond his current capabilities, as opposed to the internal representations of knowledge (Ackerman, 2001, p. 8).

Constructivism and constructionism have multiple implications for educational media. For instance, they present the novel idea that learning can be self-regulated. It also suggests experiential learning strategies should be used, in order to assist learners engage in deep reasoning and avoid passive learning. However, the most important implication is the idea that motivation for the construction of knowledge is directed internally. Piaget implies that interests are nothing more than self-generated areas of cognitive conflict (Wadsworth, 1996, p. 151). Therefore, tapping into these internal motivational structures, may prove to be an invaluable solution in keeping students actively engaged. Although Piaget's research emphasized stages of cognitive development, it suggests that universal strategies may not be effective for all learners. Therefore, curriculums should be designed to adapt to an individual's level of development (Wadsworth, 1996, p. 155).

Activity Theory

Activity theory considers the context of the activity as its basic unit of analysis. The underlying focus is on the operations undertaken by a subject as a means to achieve an objective. It suggests that intentionality is responsible for the convergence of practical knowledge with symbolic representation (Vygotsky, 1978, p. 26). Similarly, Michael Tomasello confirms this theory through studies of joint attention behavior, which is attributed to the ability to view others as "intentional agent" like the self (Tomasello, 1999, p. 61). Thus, self-generated behavior occurs as a result of a socially situated understanding of the goal pursuits of others. The theory of intentionality discredits Piaget's hypothesis that sensory motor behavior results from the "active manipulation" and "exploration of objects" alone (Tomasello, 1999, p. 57).

Activity theorist views supporting the influence of ontogeny on cognitive development contradict many core constructivist principles. For instance, Vygotsky's zone of proximal development demonstrates the ability of an individual to exceed his capabilities with assisted instruction (Vygotsky, 1978, pp. 79, 87). This refutes the constructivist view of developmental independence while promoting socially organized processes of cognitive development (Vygotsky, 1978, p. 90). Furthermore, the facilitation of internal representations by auxiliary stimuli suggests memory associations are primarily responsible for higher order function, as opposed to mental capacity. Thus, it can be inferred that cognitive development is a product of memory associations developing over time (Vygotsky, 1978, pp. 45, 47).

Activity theory has multiple implications for the design of educational media. It highlights the inadequacy of normative measures of rational thought, by presenting these strategies as backward-looking approaches to cognitive development. As studies indicate, mental development lags behind the learning process, which can be facilitated by socio-cultural methods of knowledge transmission (Vygotsky, 1978, p. 90). These findings are relevant to the field of educational technology in that they support the use of organized instruction in the development of higher level cognitive functions. In addition, they encourage designers to consider methods that not only adapt to an individual's current level of development, but that invoke forward-looking methods which advance mental development within the zone of proximal development (Vygotsky, 1978, p. 89).

Situated Activity Model

Situated activity theory considers the improvisational nature of human activity. The relationship between an individual and his environment is the primary unit of cognitive analysis (Nardi, 1996, p. 71). As Jean Lave suggests, cultural transmission is the primary method of cognitive development, therefore, the nature of mind can only be found in the "social and cultural character of human thought and action" (Lave, 1988, pp. 7, 12). This view is supported by cross contextual studies, which prove the discontinuity between situated activity and abstract problem solving (Lave, 1988, pp. 66,68). The ineffectiveness of learning transfer is attributed to the de-contextualization of the knowledge domain, which deprives learners of conceptual formations and misrepresents an individual's identity within everyday activity (Lave, 1988, p. 42).

Furthermore, Lave argues that a utilitarian model of motivation is far too simple to address the complex system of human cognition (Lave, 1988, p. 17). Situated activity theory takes a moment-by-moment view of human cognition, in which, actions are necessitated by immediate need (Nardi, 1996, p. 79). This episodic view of cognition suggests that motivation results from the process of reconciling conflicts between socio-cultural and cognitive knowledge (Lave, 1988, pp. 42, 184). However, this theory proves insufficient in addressing the dilemma of intentionality as a prerequisite for active engagement. Thus, a preliminary theory of intent is required to give a more complete explanation of human behavior.

Situated activity emphasizes the importance of context in the formation of problem solving tasks. Research indicates learning transfer in cross contextual problem solving is neither automated nor consciously applied (Lave, 1988, p. 32). Therefore educational technology should incorporate the dual roles of subject acting on the world and object acting within the world, to encourage active engagement (Lave, 1988, p. 69). Also, increased learning performance during contextual problem-solving indicates tangible objects should be used to assist the learner with problem conceptualization (Lave, 1988, p. 37). Although the role of motivation within the context of situated activity remains inconclusive, it is acknowledged that a framework for motivation should be incorporated within educational media (Lave, 1988, p. 42).

Distributed Cognition

Distributed Cognition is a branch of cognitive psychology, which is concerned with the representation of knowledge "inside the head" and "in the world" (Nardi, 1996, p. 77). A cognitive system composed of individuals and mediating artifacts is its main unit of analysis.

Distributed systems are organized around goal achievement, in which cognitive labor is divided and coordinated among system components (Hutchins, 1995, p. 176). Thus, it can be assumed that the computational and social dependencies are the same within a distributed system (Hutchins, 1995, p. 225). From this perspective, the goal is to arrange the task in such a way that the socially appropriate thing to do is also computationally correct (Hutchins, 1995, p. 225).

Edwin Hutchins promotes a distributed approach to learning, in which knowledge is propagated from one complex system to another (Hutchins, 1995, p. 290). He suggests that when cognition is observed in practice, task difficulty is determined by representational structure, as opposed to cognitive ability (Hutchins, 1995, p. 168). The process can be described as a series of transformations from the mediating structure to internal representations, which are produced by repeated interaction (Hutchins, 1995, p. 290). Just as the mediating artifact is able to direct specific action sequences, so too are the internal representations (Hutchins, 1995, p. 302). Therefore, once these states have been learned, the internal motor medium executes the tasks automatically without reference to the external structure (Hutchins, 1995, p. 308). Therefore, cognitive ability is assisted by the representational affordances of the computational system (Hutchins, 1995, PP. 117, 155).

The theory of distributed cognition has strong implications for ITS systems. It suggests that ITS systems can be viewed as mediating artifacts, in which internalization occurs through continued practice. Research indicates that feedback should be incorporated within the design to allow the learner an opportunity to refine the construction of meaning. Therefore, the objective is to coordinate internal and external representations of the artifact in a manner that assists the learner with problem-solving tasks by stimulating appropriate cognitive activity. Thus, the type of feedback in ITS systems should be constrained by the curriculum as well as the learner's representational state. These components create within the artifact a mediating structure, in which the curriculum is transformed and propagated to the learner. Thus, once the procedures have become automated, the mediating artifact is no longer required.

Motivation

A Social-Cognitive Approach

Carol Dweck presents a social-cognitive approach to the study of motivation, in which an individual's performance is a product of his self concept (Dweck C. , 1988, p. 257). Goal orientation refers to the perceptions and behaviors of the learner during an achievement task. For instance, if an individual believes intelligence is fixed; he is more likely to adopt performance goals. However, if an individual believes intelligence is malleable he is more likely to adopt learning goals. Learning and performance goals are characterized by the desire of an intrinsic learner (IL) to increase competence and of an extrinsic learner (EL) to gain favorable judgments (Dweck C. , 1988, p. 256). Therefore, when confronted with challenge and or failure, mastery oriented or performance oriented behavior will emerge in ILs and ELs, respectively.

An individual's level of effort is a key indicator of goal fulfillment (Dweck C. , 1988, p. 260). Research indicates that ELs perceive an inverse relationship (inverse rule) between effort and ability, while ILs perceive a direct relationship. Therefore, similar outcomes have different indications for success based on an individual's goal orientation. For instance, an adaptive pattern of positive self-cognition will produce increased effort and learning performance in ILs. While maladaptive patterns of negative self-cognition will produce negative affect, which leads to reduced effort and learning performance for ELs. Not only do these findings provide a motivational framework, they also support the claim that intentionality is a prerequisite for active engagement.

An Expanded View of Motivation

Although the mastery-performance dichotomy has been validated empirically as a key indicator of behavior, researchers argue that the intricacies of individual motivation are more complex than the simplistic relationship suggested by this model. Therefore, Elliott and McGregor present an enhanced model, which adds an additional dimension to the motivational framework (Elliot & McGregor, 2001, p. 517). Their research indicates not only do individuals differ by their preferential achievement goals, but also in the way competence is perceived. For instance, competence can be viewed in terms of a positive or negative outcome. Elliot and McGregor also attribute the generation of promotional (eager) and preventive (vigilant) methods of goal pursuit to these valence components.

These components demonstrate the multifaceted nature of goal orientation, as the maladaptive pattern is not as easily predicted from the 2x2 Achievement Goal Framework (Table 2).

Table 2 2x2 Achievement Goal Framework

	Extrinsic	**Intrinsic**
Vigilant	Performance Avoidance	Mastery Avoidance
Eager	Performance Approach	Mastery Approach

For example, although performance-avoidance and mastery-approach have clear delineations toward the maladaptive and adaptive behavioral patterns, mastery-avoidance and performance-approaches are not as clearly defined (Elliot & McGregor, 2001, p. 516). Because these two constructs contain a combination of components, they may possess some suboptimal strategies, such as disorganized studying or worry, however, they are not necessarily predictors of negative outcomes. However, Elliot and McGregor, suggests that these two dispositions could cause conflicts in environments which foster optimal achievement methods and intrinsic methods of goal pursuit (Elliot & McGregor, 2001, p. 516).

Limitations within the traditional mastery-performance approach suggest a more robust model could have a significant impact on task-performance. As a fear of failure remains the most common threat to productivity, ITS systems should attempt to refocus attention to more optimal strategies. Thus, the ideal system would consistently orient a learner's behavior towards maximizing performance and pride in his abilities, regardless of how his abilities may be evaluated (Dweck C. , 1988, p. 261). It also implies that artificial incentives, such as scoring and praise could be used more strategically to provide customized instruction that suits the individual's needs. As Elliot and McGregor's research indicates, systems that promote optimal and intrinsic strategies may present a fundamental conflict with an individual's goal orientation. Therefore, a system that is able to provide adaptive instruction would circumvent the limitations of stimulus response.

Instructional Models

Analysis of Feedback Type and Learner Characteristics

Although feedback is one of the most powerful instructional tools in ITS systems, it is still widely misunderstood. Conflicting evidence contradicts its ability to improve motivation, reduce cognitive load, and correct misconceptions. Consequently, it is necessary to understand the underlying factors that influence its effectiveness, in order to use feedback constructively. Analyzing the effects of feedback types on individual properties of the learner is essential in improving system interaction. Thus, this research examines the most effective feedback types based on learner experience level and goal orientation.

Feedback Types Discussion

Feedback techniques could hinder task performance if the effects of multiple learner characteristics are not considered. For example, it may be assumed that a directive approach, using "gentle guidance," would be more appropriate for ELs, and that facilitative hints would be most effective for ILs. However, if we consider learner experience, it is clear that a constructivist approach is an ineffective strategy for novice learners. As it places excessive amounts of cognitive load on mental effort and decreases post learning performance (Clark & Feldon, 2005, p. 109). In contrast, experts perform better in less structured environments. Therefore, supportive feedback should provide detailed instruction to novice and intermediate students, while less detailed instruction should be provided to expert learners. Table 3 below provides a general framework for feedback types in relation to learner ability and orientation.

Table 3 Feedback Framework Consolidated from "Formative Feedback," V. Shute, 2008

	Low Achievement		**High Achievement**	
Orientation	Intrinsic	Extrinsic	Intrinsic	Extrinsic
Timing	Immediate	Immediate	Delayed	Delayed
Scaffolding	Directive	Directive	Facilitative	Facilitative
Detail	Elaborated	Elaborated	Verification	Verification
Correction Type	Topic Contingent	Topic Contingent	Verification	Verification
Goal Orientation	Self-Referenced	Self-Referenced	Self Referenced	Normative

A variety of feedback options are available, which support specific design features. Although delayed feedback initially slows the rate of initial learning, it is considered superior to immediate feedback during concept formulation (Shute, 2008, p. 165). Therefore, immediate feedback is considered most effective in reinforcing corrective actions during difficult tasks. In addition, normative comparisons of peer performance have also proven detrimental to the confidence of low achievers, while self-referenced feedback generally increases effort and expectations of future performance (Shute, 2008, p. 167). Table 3 deviates from this approach for experienced extrinsic learners, in order to appeal to their competitive nature.

Regulatory Fit

Motivation is considered a key component to a learner's overall success. If motivation is a result of an individual's interpretation of experience, this implies that feedback can potentially influence individual perceptions. One such strategy used by the advertising industry has been to use regulatory fit to change attitudes and behavior (Cesario & Higgins, 2007, p. 444). Regulatory Fit Theory combines the individual's motivational orientation with his preferred means of goal pursuit, in order to structure the message in such a way that the individual "feels right" about it. Tomasello also supports the ability of language to persuade a person to take a certain perspective (Tomasello, 1999, p. 151).

Perspective taking involves the adaptation of the message content to a form that best fits the communicative intent of the interlocutor (Tomasello, 1999, p. 155). Regulatory fit is used to address the valence component of the motivationally enhanced coach (MEC) in VBT version B (see Table 4). It suggests that recommended actions (promotional strategies) towards goal attainment are effective for eager learners, while precautionary recommendations are effective for vigilant learners. This is accomplished by framing the action or attributes of the activity with an emphasis on its negative or positive outcome. The key to message effectiveness is to establish a promotion or prevention focused position congruent with the recipient's orientation. Research shows that regulatory fit increases the recipient's positive attitude and engagement. Thus, it is suggested that the implementation of regulatory fit techniques during feedback may cause the learner to be more receptive to correction.

Gestures

Another important factor in the design of feedback is the use of nonverbal gestures. Hutchins suggests that the quality of a message depends on how the message is interpreted, as opposed to its content (Hutchins, 1995, p. 231). This implies that the meaning of an utterance can only be understood in the context of the task being performed. In fact, during face-to-face communication, multiple channels of communication are used to express the context of the message. Backchannel cues such as prosody, body language, and deictic gestures help communicate intent during face-to-face communication (Dix, Finlay, Abowd, & Beale, 2004, p. 483). Hutchins suggests that a characteristic of effective information systems is the incorporation of expressive cues to structure the message (Hutchins, 1995, p. 236).

Although a gesturing component was included in the initial proposal for the MEC, it was not implemented in VBT version B, as the introduction of gestures in one system would cause an inconsistency that would confound the results of the evaluation. For instance, if learning performance were increased, it would be problematic to attribute the feedback or the gesturing with the benefit (Clark & Feldon, 2005, p. 107). Therefore, the gesturing will be included as an area of future work.

Menu Driven Verses Natural language

ITS systems that are modeled after one-to-one human tutors are significantly different from simulation-based systems that include pedagogical agents. For instance, human modeled systems are more likely to contain natural language input/output to encourage collaborative feedback. The inclusion of natural language features has recently become a trademark of “sophisticated ITS systems.” Natural language systems are able to analyze responses from the interactor and enable the system to generate a variety of post-hoc feedback types. Although simulation-based systems can contain natural language features, many systems, such as the VBT, remain menu-driven to avoid the problem of language ambiguity. The problem is attributed to a lack of contextual cues during human-computer interaction.

Although menu-driven systems remain less flexible than natural language, various attributes make them a preferred strategy. For instance, turn taking can be utilized in order to engage in more collaborative feedback. Since collaborative dialog consists of a pattern of recursive structures, it can be simulated in menu-driven systems by generating a corrective response in coordination with the interactor's dialog selection until a correct selection has been received. See Appendix A Figure 9 for more details. Also, the main benefit of a menu-driven system is its ability to reduce cognitive load, by providing cues that aid in memory recognition. Menu-driven feedback also leverages standard conventions by exploiting the learner's familiarity with graphical user interfaces, in order to maximize task-performance (Dix, Finlay, Abowd, & Beale, 2004, p. 261).

CHAPTER 3

VIRTUAL BNI TRAINER PROJECT

The VBT is a practice environment designed for medical residents at the Yale School of Medicine. It enables residents to develop their clinical skill, by allowing them to conduct a simulated Brief Negotiation Interview (BNI) with a VP. BNIs are short counseling sessions (5-60 minutes) that incorporate feedback, advice, and motivational enhancement techniques to assist the patient in reducing their alcohol consumption by referring them to treatment programs.

The BNI procedure was first developed in 1994 by Drs Edward Bernstein, Judith Bernstein, and Gail D'Onofrio in consultation with Dr. Stephen Rollnick. The success of this model has led to its implementation in emergency rooms across the nation, which has increased the demand for trained Health Promotion Advocates (HPAs). While the techniques are relatively simple to teach, they require a large amount of instructor effort in workshop preparation and facilitation. Therefore, in order to meet these demands, program coordinators have sought a more efficient method of delivery.

The following section provides a brief overview of the learning domain and project relevance. In addition, a detailed description of the VBT design architecture is presented. The VC design features are emphasized, in order to illustrate how the basic coach (BC) and MEC features support two distinct learning theories.

Project Conception

Screening Brief Intervention and Referral to Treatment (SBIRT)

Substance abuse has been identified as the major contributing factor in the number of trauma injuries treated by Emergency Departments (ED). Despite this fact, health care professionals remain reluctant to screen patients for substance abuse during routine and emergency visits. As a result, only 10% of patients with dependence receive access to treatment (Fleming, et al., 2009, p. 387). The Screening Brief Intervention and Referral to Treatment (SBIRT) was developed to address these issues. SBIRT is a collaborative model for behavioral change through BNI strategies.

Project Relevance

SBIRT are skills, which must be practiced in order to become natural. Initial attempts at using these techniques are usually quite awkward. If practitioners are unable to overcome initial reservations due to lack of patient familiarity, they will be less likely to incorporate them into practice. In addition, traditional training workshops require a large amount of instructor effort and student attentiveness. Therefore, the VBT was designed to improve the skill of medical professionals when conducting screenings for alcohol dependence, by providing them with an online practice environment. Currently, the system consists of a generic patient scenario based on the four step BNI protocol.

Virtual Coaching

Virtual coaching is a remediation strategy, which utilizes pedagogical agents to provide assisted learning and instructional support via a simulated environment. Simulated environments provide a self-paced, realistic, and cost effective alternative to the traditional classroom, without the capacity limitations. In addition, they also present an opportunity to gain valuable experience in a controlled setting. Animated pedagogical agents have become a common feature of sophisticated ITS systems. Studies show that the use of pedagogical agents in simulated environments promotes student engagement in the cognitive process (Moreno, 2005, p. 517).

Two types of ITS technologies are currently implemented in the VBT: (1) the VC, and (2) VP. The VC is used during formal consultations to provide response contingent feedback, while the VP provides the learner with gestural cues, which indicate his performance. Artificial Intelligence (AI) techniques enable standard ITS components such as knowledge tracing, feedback, and skills summary.

Two Learning Perspectives

One of the main benefits of ITS systems is their flexibility in accommodating a variety of learning styles. A common pedagogical approach is to provide different versions of the same lesson to a variety of learning styles (Clark & Feldon, 2005, p. 111). According to Mayer and Massa, the two most promising models are based on differences in learner experience and goal orientation (Clark & Feldon, 2005, p. 111). Examples of adaptability include the ability to respond with context appropriate feedback, design customized instruction, and assess student level of mastery.

Two distinct learning theories are used in the design of the two VBT versions. VBT version A consists of a BC, which scaffolds the learner according to his experience level. VBT version B consists of the MEC, which uses the achievement goal construct (Table 4) to provide appropriate feedback in accordance with the learner's goal orientation. Although both methods provide customized feedback, responses are based on two different assessments of the learner's needs. Despite the underlying model, both versions attempt to redirect the learner to the correct BNI procedure in the event of an incorrect patient response.

Virtual BNI Trainer System Analysis

The VBT is designed as a distributed system in which components are coordinated to achieve the specific objective of training learners on the BNI protocol. Therefore, as Hutchins suggests, we can gain a better understanding of how learning occurs in functional systems, by using the VC instructional model as the unit of cognitive analysis. Hutchins promotes three main levels of information processing systems essential to its understanding. First, the computational level explains what the system does, why it does it, and constraints that it satisfies (Hutchins, 1995, p. 50). The VC instructional model is essentially a tool to improve motivation, reduce cognitive load, and correct misconceptions about BNI principles. Thus, feedback constraints consist of information communicated to the learner that will have a positive impact on task-performance in relation to his current representational state (see Table 2).

The second level specifies the choice of representation for the input and output and the algorithm used to transform one into the other. Input to the VBT is provided in the form of dialog selection, which is evaluated for accuracy. In the event of an error, feedback is provided based on the VC remediation structure. The BC uses the learner's actual experience level to determine the degree of feedback required to assist with his potential development. Although the MEC maintains a static model of the learner's goal orientation, it contains two levels of interaction, which is designed to respond to the learner's achievement goals and method of pursuit (see Appendix B). Thus, the feedback is in direct relation to the learner's intentions. These models exploit Vygotsky's theory of the zone of proximal development and Tomasello's theory of intentionality as an organizing property of human behavior.

The third level describes how the algorithm and representations are realized physically (Hutchins, 1995, p. 50). Both VC models incorporate knowledge of the learner and BNI protocol, which is embedded within the system, in order to enhance the level of communication (Hutchins, 1995, p. 262). For instance, the VC feedback must be coordinated with the specific competencies and criterion being tested and the type of error made in order to provide a context appropriate response. Thus, the system's knowledge of the BNI protocol and knowledge of the individual learner creates a distributed computational system in which internal and external knowledge is used to simulate a social environment (Hutchins, 1995, p. 117).

Virtual BNI Trainer Version A: Basic Coach Design

Knowledge Trace and Scaffolding

AI techniques, such as model-tracing are used by the BC to map competencies and criteria to the learner's experience level via a series of production rules. For instance, the BNI training has been categorized into a series of competencies (G) which the learner will be evaluated on (see Figure 1 below). Detailed information can be found in APPENDIX A: Competencies and Criteria. By monitoring the learner's response to questions mapped to specific criteria (F), it is possible to accurately access the learner's current experience level when compared to the ideal system model.

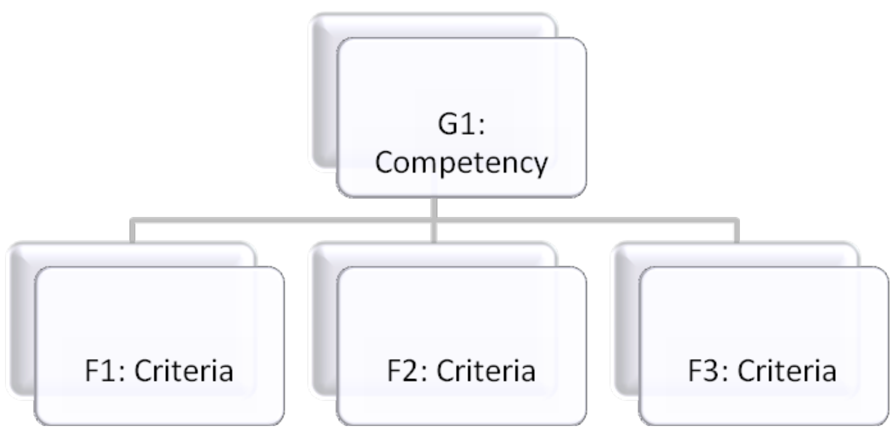

Figure 1 Competency and Criteria Hierarchy

The BC production rules consist of performance distributions (f) for a particular criterion (F). Performance distributions of fuzzy variables (f), represents attributes of the learner's level of competence. The variables are rolled up from the local to global level for a particular competency (Katz & Lesgold, 1992, p. 111).

The degree of feedback elaboration is determined by the performance distribution of the knowledge trace (see APPENDIX A: Competencies and Criteria). For each performance condition (F) the upgrade or downgrade value is calculated based on its index (see APPENDIX A: Fuzzy Set Logic Calculations). After the result sets for F have been calculated the performance distribution (g) for the global variable (G) is calculated. Once completed, the largest variable in the performance distribution for the global variable (G) indicates the learner's knowledge state. The knowledge state is then mapped to one of three experience levels (novice, intermediate, or expert), which determines the degree of feedback received. Thus, the level of detail fades as a result of the learner's progression in experience (see Figure 9 BC Feedback/Knowledge Trace Flowchart). This strategy is consistent with studies indicating novice and intermediate learners require more structured guidance than expert learners.

Virtual BNI Trainer Version B: Motivationally Enhanced Coach Design

Achievement Goal Construct

The objective of the MEC is to provide instruction in a manner which appeals to the learner's goal orientation. It provides ILs with a challenging environment, as well as encourages ELs to persist with the task by desensitizing them to emotional distress (Bandura, 1977, p. 199). In addition, recommendations are framed as precautionary steps that appeal to vigilant learner's desire to avoid negative outcomes. In contrast, eager learners will receive recommendations framed as progressive steps towards positive outcomes (Cesario, Higgins, & Scholer, 2007, p. 445). Thus, the MEC aims to support multiple achievement goals and methods of pursuit, which are integrated according to goal orientation (see Table 4 below).

Table 4 Achievement Goal Feedback Construct

	Encouragement	Challenge
Prevention	Performance Avoidance	Mastery Avoidance
Promotion	Performance Approach	Mastery Approach

MEC Goal Oriented Feedback

The MEC was developed to support the Achievement Goal Construct (Table 4). Because the goal of the design is to evaluate the effects of adaptive instruction on learner motivation, the MEC must provide a moderately difficult environment. Therefore, scaffolded feedback was disabled for the MEC. Also, two types of MEC feedback was authored (see APPENDIX B). The first type is goal setting feedback, which consists of challenge questions (CQ) designed to prompt increased engagement (ex." Is there another approach?), and encouragement statements (ES) designed to reduce performance anxiety and help learners focus (ex. "You can do this, let's try a different approach."). The second type is corrective feedback (CF), which consists of promotion statements (PS) designed to provide a means of advancement (ex. "Remember to set a comfortable climate and establish trust."), and avoidance statements (AS) designed to prevent mistakes (ex. "Remember to avoid appearing distant or inattentive."). Table 5 displays the four goal orientation categories, along with their corresponding MEC motivational feedback.

Table 5 MEC Response by Goal Orientation

Categories	Challenge	Encourage	Promotion	Avoidance
Mastery-Approach	X		X	
Mastery-Avoidance	X			X
Performance-Approach		X	X	
Performance-Avoidance		X		X

Virtual Coach Remediation Structure

VBT Error Types

The VBT monitors three types of errors to determine when remediation is required. Order Errors occur when a category is selected out of sequence with BNI procedures. Although patient interaction is initiated by the learner during dialog selection, category selection controls the dialog options available. For example, in Figure 2 below, the category menu consists of the vertical navigation bar in the lower left corner. If the appropriate BNI step in the training is greet, then the selection of any other category would be flagged as an Order Error.

Figure 2 Selection Menu

Fatal Errors occur when VBT dialog selection is offensive or insensitive, which may undermine the effectiveness of the BNI. For instance, in Figure 2, the dialog menu consists of the horizontal navigation bar in the lower right portion of the screen. The dialog option "I am the doctor. We are going to talk about your drinking issues" is an example of a Fatal Error. The statement's authoritative and insensitive tone could be viewed as confrontational by the patient, which would undermine any further attempts to provide treatment. In contrast, Non-fatal Errors occur when dialog selection does not completely satisfy the BNI protocol, but does not deter a referral to treatment. The dialog option "Hi there, do you mind if we discuss something?" in Figure 2 is an example of a Non-fatal Error. The statement lacks a formal introduction and is far too vague for the patient to make an informed response.

The VC remediation structure is designed to respond to all three types of errors. BC and MEC responses remain consistent with their respective learner models. The structure of the VC response on Fatal and Non-fatal Errors is the main difference between versions. For instance, the BC provides the learner with scaffolded feedback as appropriate to his experience level, in support of the BC Feedback/Knowledge Trace Flowchart (APPENDIX A). In contrast, the MEC supports the MEC Feedback Construct (APPENDIX B). However, Both VC versions are constrained to a static "Try-Again" response on Order Errors, which was not a part of the adaptive design. This constraint was a compromise by the development team to ensure the completion of the prototype without the overhead of large amounts of dialog authoring. Both designs are depicted in Table 6 below.

Table 6 VC Remediation Structure

	BC Feedback	**MEC Feedback Type**
Fatal	Scaffolded	Goal Setting +Corrective
Non-fatal	Scaffolded	Corrective
Order	Try-Again Response	Try-Again Response

The BC response must satisfy both the Feedback Flowchart (Figure 9) and Remediation Structure (Table 6). Figure 3 illustrates the BC's intermediate response, upon the fatal dialog selection "I am the doctor. We are going to talk about your drinking issues" shown in Figure 2.

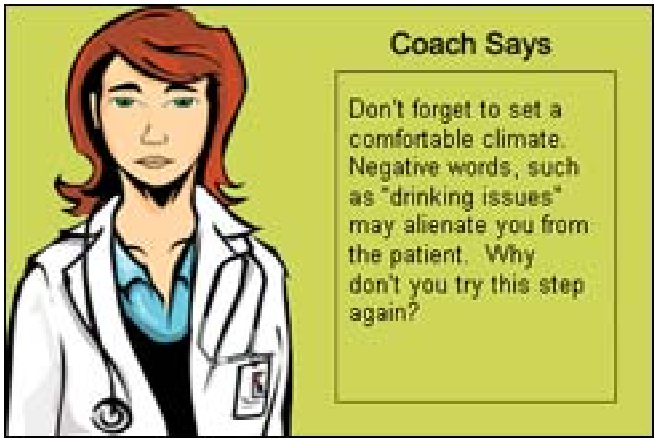

Figure 3 BC Fatal Error Response

Figure 4 displays an example of the MEC's performance-avoidance response, upon selection of the same fatal dialog in Figure 2. The response begins with an ES statement, which is then followed by an AS statement. This statement satisfies both the MEC Response by Goal Orientation (Table 5) and VC Remediation Structure (Table 6).

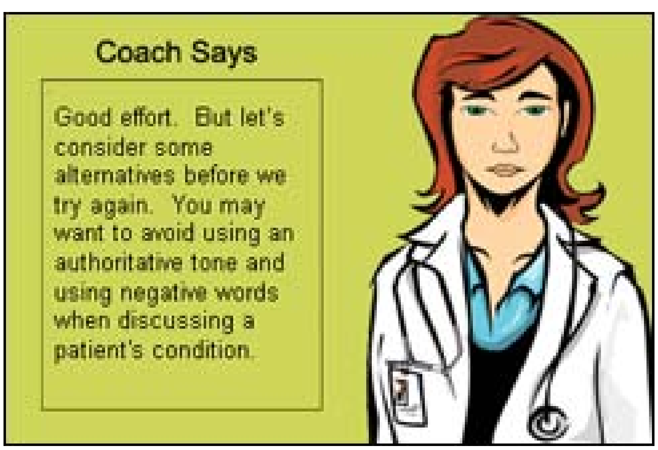

Figure 4 MEC Fatal Response

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

The objective of this research is to evaluate the effectiveness of goal orientation on motivation and performance. Although the value of costly error analysis has been debated in terms of its current performance limitations, further evaluation is required to understand how feedback can improve learning outcomes. The following experiment seeks to evaluate the effectiveness of two VC instructional designs, embedded in two separate versions of the VBT. The BC uses a model of the learner's experience level, while the MEC uses a model of the learner's goal orientation to provide motivational support during error detection. As such, my research quantifies the effects of adaptive instruction on 1) student self-efficacy, 2) engagement, and 3) learning performance in both VC versions. My objective was to validate the effects of goal orientation on learner motivation and derive guidelines for the construction of context appropriate feedback.

The main component of my research is the instructional design of the VC remediation structure, and their subsequent evaluation. Although, both VC versions are based on a situated approach to human cognition, the MEC was designed specifically towards increasing learner motivation and self-efficacy. It was my initial assumption that it would score higher in terms of the three measures of learning motivation (previously indicated) than the BC. Therefore, I started with some broad research questions comparing the effectiveness of both VC versions to increase learning performance. During the controlled experiment, data was collected from a combination of observation and query techniques, such as computer logging, surveys, and post-training interviews. However, during the course of the experiment, I found the results presented new questions, which required me to revise my original research questions and design. The revised experimental design will be presented later in this chapter.

Experimental Design

One of the most powerful methods of evaluation is the controlled experiment. Empirical evidence can be used to substantiate claims by determining the significance of test results. Therefore, it is important that researchers carefully consider the experimental design, in order to ensure the validity of evaluation results. The main difference between a case study design and an evaluation is that the former is used to generate requirements for a physical artifact, while the latter is used to test the implementation (Dix, Finlay, Abowd, & Beale, 2004, p. 357). The following five steps can be used to guide the design of a research investigation:

1. Formulate the hypothesis,
2. Determine the research question,
3. Determine experimental conditions
4. Choose the experimental method, and
5. Determine the method of analysis.

In order to illustrate these steps, we can consider their application within the VBT.

1. Hypothesis: Goal orientation will improve learner motivation and performance.
2. Research Question: Questions targeted the effects of goal orientation on self-efficacy, engagement, and performance.
3. Experimental Conditions: Consisted of feedback styles, size of the experiment, participants, and the unit of analysis (see Table 7 below).
4. Experimental Method: Consisted of a laboratory study between-subjects.
5. Analysis Method: A quantitative analysis of numerical measures of effectiveness was compared across groups.

Table 7 Experimental Conditions

Components	Description
Independent Variable	2 feedback styles
Dependent Variable	1 User response
Size of Experiment	2 (Independent x Dependent)
Participants	GT student 18 and over
Unit of Analysis	Dialog selection and VC response

Since the experiment compared the effects of two instructional designs, the independent variables were classified as discrete. The dependent variable was subject to changes made to the independent variables. Therefore, it was assumed that the dependent variable variation followed a normal distribution, so a parametric test was the preferred statistical method. Because the discrete independent variables had more than one level (System and Goal Orientation) and a known dependent variable distribution, Dix and colleagues suggested an analysis of variance (ANOVA) for the statistical method (Dix, Finlay, Abowd, & Beale, 2004, p. 338).

Controlled Experiment

As a single-user system, the VBT was an ideal environment to test the effects of adaptive instruction on student performance. Instruction was delivered solely by a pedagogical agent, which simplified modifications to pedagogical strategies and observations of their causal impact. Although medical professionals were the target audience of the VBT, the following preliminary evaluation was conducted on a sample of 40 participants recruited from the Georgia Institute of Technology. In order to provide unbiased results, a controlled experiment was conducted, consisting of participants ages 18 to 40, multiple ethnicities, and both genders. A sizeable quantity of participants was required to ensure an adequate sampling with varying degrees of intrinsic value during interaction.

The experiment was designed to support a comparative analysis of the participant's performance and subjective experience during system interaction. 20 participants were randomly assigned to VBT version B (MEC experimental group) and the remaining 20 assigned to VBT version A (BC control group). Originally all 40 participants were to receive BNI video training prior to system interaction. Since, most participants were unfamiliar with the BNI protocol; they were provided with video training, which was equivalent to the actual training received by residents at the Yale School of Medicine. This measure was an attempt to make the participants more representative of the intended user population. As Dix and colleagues suggest, if participants are not actual users, "they should be chosen to be of similar age and level of education as the intended user group" (Dix, Finlay, Abowd, & Beale, 2004, p. 329).

After participants viewed a brief training video, they were instructed to complete the Learning Motivation Pre-Assessment Survey. After their goal orientation had been determined via the pre-assessment, participants were directed to start the training scenario. MEC feedback provided goal oriented instruction to participants in the experimental group, while the control group received scaffolded instruction from the BC as previously discussed (Table 6). After completion of the training, participants evaluated the effectiveness of the system via the Training Experience Post-Assessment Survey. After which, a brief open-ended interview was conducted with each participant. The total time for participation was approximately 1 hour 15 minutes.

Revised Controlled Experiment

Initial interviews revealed a problem with the delivery of the MEC's goal setting feedback (Table 6). Subsequent analysis confirmed a lack of Fatal errors committed by participants prevented the MEC's goal setting feedback from being delivered. This problem would have caused an inability to evaluate the effectiveness of the MEC's goal setting feedback in VBT version B. Therefore, the video training was removed, in order to increase the difficulty and probability of Fatal errors. A handout, consisting of the four main components of the BNI (APPENDIX C), was substituted for the video training for the remaining participants. Although participants were allowed to reference the handout throughout the training, five minutes were allotted to each participant to review the handout and ask questions before proceeding to the Pre-Assessment Survey. Therefore, participants were divided into Video and Non-video training groups (Table 22).

Research Method

Subjects and Sampling

The subjects for the controlled experiment were recruited from the Georgia Institute of Technology. All experiments were conducted in the Adam Lab at Georgia Tech's Technology Square Research Building. The experiment was implemented over the course of two weeks. Participants were paired in groups of two, in which, each participant was assigned to different VC versions. All students were recruited using campus advertisements and word-of-mouth. Demographic information (major, classification, and gender) and availability was requested from all participants. After recruiting a sizable number of participants, a snowball sampling technique was employed, in which, participants were asked to recommend colleagues who would be interested in joining the experiment. A testing schedule was created for all participants based on their availability and all participants were notified of their testing time and location by email.

The sample size consisted of an equal number of participants. As individual goal orientation was determined during the actual experiment, the goal of the initial recruitment was to gather an equal number of participants by gender. The 40 participants were divided into two training groups. Each group consisted of 20 participants, in which 10 were assigned to the BC and 10 assigned to the MEC. Table 8 below depicts the sample size by training group.

Table 8 Population Size by Training

Training	System	Gender	Participants
Video	BC	Female	4
		Male	6
	MEC	Female	4
		Male	6
Non-video	BC	Female	4
		Male	6
	MEC	Female	4
		Male	6

Although participation was open to all majors, the demographic was densely populated with students from two majors (ENG and DM) and interspersed with an eclectic mix of others as well (see Table 9 below). Please see List of Abbreviations for more details.

Table 9 Population Size by Major

Major	Grad	Undergrad
BA	0	1
BIO/BCH	0	1
DM/CM	11	2
CS	3	0
ECON	0	1
ENG	2	12
HCI/HCC	2	1
IAML	0	3
STC	0	1
TOTAL	18	22

<u>Surveys</u>

A survey is a query technique, in which fixed questions are administered to participants. The Pre-Assessment Survey was used to determine the learner's goal orientation. The survey was modified from the Game Achievement Goals survey, created by Dr. Carrie Heeter, Creative Director at Michigan State University. The Pre-Assessment Survey was used to assess the participant's goal orientation from the four combinations listed below, as referenced by the 2x2 Achievement Goal Framework (Table 2):

1. Mastery Approach (MApproach)
2. Mastery Avoidance (MAvoid)
3. Performance Approach (PApproach)
4. Performance Avoidance (PAvoid)

Once the participants were categorized by goal orientation, the Expanded MEC Instructional Model (see Table 10 below) was used to construct the MEC response during training.

Table 10 Expanded MEC Instructional Model

Errors	Orientation	Feedback
Fatal	MAvoid	CQ +AS
	MApproach	CQ+PS
	PAvoid	ES+AS
	PApproach	ES+PS
Non-fatal	MAvoid	AS
	MApproach	PS
	PAvoid	AS
	PApproach	PS
Order	MAvoid	Try-again Response
	MApproach	Try-again Response
	PAvoid	Try-again Response
	PApproach	Try-again Response

The Post-Assessment Survey was designed to evaluate the VC's ability to maintain learner motivation during the training. A two-tier model of effectiveness was used to evaluate the VC's performance. The top-tier consisted of the two measures of learning motivation (self-efficacy and engagement), while the second-tier consisted of their subcomponents. All post-assessment questions were mapped to these subcomponents and scalar values were used to assess the participant's level of agreement. Therefore, these subcomponents were used as evaluation criteria, which were subsequently rolled up to the two main measures of effectiveness.

The evaluation criteria for self-efficacy consisted of the following: 1) Affect, 2) Confidence, 3) Regulation, and 4) Effort. Affect questions measured the VC's effectiveness in eliciting a positive attitude from the learner. Confidence questions evaluated the VC's ability to nurture within the learner high value judgments of their ability. In contrast, Regulation questions measured the VC's ability to mitigate negative affect. Finally, Effort questions evaluated the VC's performance in increasing the learner's level of concentration during difficult tasks.

The evaluation criteria for engagement consisted of 1) Feeling Right, 2) Attention, and 3) Persuasion. Feeling Right questions evaluated the VC's response in terms of its congruence with the learner's goals. In contrast, Attention questions measured the VC's ability to maintain the learner's attentiveness. Finally, Persuasion questions evaluated the persuasiveness of the VC's corrective response. Thus, VC effectiveness was measured in terms of the participant's attitude toward the BC or MEC during interaction (i.e., how competent or favorable they felt). In order to quantify the participant's subjective experience, survey questions were mapped to a quantitative 7-point Likert scale. Task performance was measured in terms of the number of inaccurate responses logged.

Data Collection

Part 1 Pre-Assessment Survey

The following statements are focused on your goals when you take (or used to take) classes. There are no right or wrong answers; please just answer as accurately and honestly as possible.

Not at all true of me 1234567 Very true of me

1. My goal is to ...do better in my classes than other students.
2. My goal is to ...get as high a grade as possible in my classes.
3. My goal is to ...avoid doing worse in my classes than other students.
4. My goal is to ...avoid missing any of the answers on tests in my classes.
5. My goal is to ...do well compared to other students.
6. My goal is to ...get as high a score on my tests as I possibly can.
7. My goal is to ...not do poorly compared to other students in my classes.
8. My goal is to ...miss as few of the answers on my tests as I possibly can.
9. My goal is to ...perform better in my classes than others.
10. My goal is to ...get all of the answers correct on my tests.
11. My goal is to ...avoid performing worse than others in my classes.
12. My goal is to ...not miss any of the answers on my tests.

Goal Orientation (average of the following questions):	
Mastery Approach:	Questions 2, 6, 10
Mastery Avoidance:	Questions 4, 8, 12
Performance Approach:	Questions 1, 5, 9
Performance Avoidance:	Questions 3, 7, 11

Part 2 Post-Evaluation [Engagement]

Using the following scale, please rate how much you agree or disagree with each of the following statements. Ask yourself: How much does this statement reflect how I experienced this set of questions?

Disagree Strongly 1234567 Agree Strongly

1. I was attentive to the virtual coach feedback. (+) – attentive (b)
2. The virtual coach feedback did not address my concerns. (-) – feeling wrong(a)
3. The virtual coach feedback increased my concentration. (+) – attentive (c)
4. The virtual coach feedback did not support my goals. (-) – feeling wrong (e)
5. I was persuaded to follow the advice of the virtual coach. (+) – persuaded (d)
6. I felt good about the virtual coach feedback. (+) – feeling right(a)
7. I didn't pay attention to the virtual coach feedback. (-) – inattentive(b)
8. The virtual coach feedback helped me achieve my goals. (+) – feeling right (e)
9. I was not receptive to the virtual coach feedback. (-) – unpersuasive (d)
10. The virtual coach feedback was distracting. (-) – inattentive (c)

Evaluation Criteria (average of the following questions): Feeling Right: Questions 2a, 4e, 6a, 8e Attention: Questions 1b, 3c, 7b, 10c Persuasion: Questions 5d, 9d Note: All negative questions should use the formula (7-score)

<u>Part 3 Post-Evaluation</u> [Self-Efficacy]

Using the following scale, please rate how much you agree or disagree with each of the following statements. Ask yourself: How much does this statement reflect how I experienced this set of questions?

Disagree Strongly 1234567 Agree Strongly

1. I felt frustrated during the training.- Initial Regulation (d)
2. I felt anxious about my performance during the training.- Initial Regulation (f)
3. The virtual coach feedback eased my frustration with my performance during the training. (+) – Follow-up Regulation (d)
4. The virtual coach feedback calmed my anxiety when I made an error. (+) – Follow-up Regulation (f)
5. The virtual coach feedback made me believe I could do well during the training. (+) – Confidence (b)
6. The virtual coach feedback made me feel optimistic when I made an error. (+) –Affect (a)
7. When the virtual coach prompted me to think critically, I was confident in my abilities. (+) – Confidence (c)
8. The virtual coach feedback made me feel determined when I made an error. (+) – Affect (e)
9. The virtual coach feedback helped me increase my effort. (+) – Effort (g)
10. The virtual coach made me feel self-conscious about making errors. (-) – Affect (a)
11. The virtual coach feedback was not reassuring during the training. (-) – Confidence (b)
12. The virtual coach feedback made me feel embarrassed when I made an error. (-) – Affect (e)
13. The virtual coach feedback reduced my effort during the training. (-) – Effort(g)
14. I was discouraged, when the virtual coach asked me to think of other alternatives. (-) – Confidence (c)

<u>Evaluation Criteria (average the following questions with the exception of Initial Regulation questions):</u>
Affect: Questions 6a, 8e, 10a, 12e
Confidence: Questions 5b, 7c, 11b, 14c
Initial Regulation: Questions1d, 2f
Follow-up Regulation: Questions 3d, 4f
Effort: Questions 9g, 13g
Note: All negative questions should use the formula (7-score)
Note: Scores from Initial Regulation questions are not added to subtotals or totals, If Initial Regulation is equal to or greater than 4 then include the corresponding Follow-up Regulation score, otherwise exclude both the corresponding Follow-up Regulation score as well.

Learning Motivations Pre-Assessment Survey

The following statements are *focused on your goals when you take (or used to take) classes*. There are no right or wrong answers; please just answer as accurately and honestly as possible.

My goal is to do better in my classes than other students.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to get as high a grade as possible in my classes.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to avoid doing worse in my classes than other students.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to avoid missing any of the answers on tests in my classes.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to do well compared to other students.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to get as high a score on my tests as I possibly can.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to not do poorly compared to other students in my classes.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to miss as few of the answers on my tests as I possibly can.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to perform better in my classes than others.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to get all of the answers correct on my tests.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to avoid performing worse than others in my classes.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal is to not miss any of the answers on my tests.
Not at all true of me 1 2 3 4 5 6 7 Very true of me

Thank you for your time and responses!

Training Experience Post-Assessment Survey

Below are statements about your experience during the training, with which you may agree or disagree. Please read each of the following items carefully. Using the scale below, choose the number that best describes how **you** think and act **in general**. Please be open and honest in your responding - there are no right or wrong answers.

	Strongly Disagree						**Strongly Agree**
1. I was attentive to the virtual coach feedback.	1	2	3	4	5	6	7
2. The virtual coach feedback did not address my concerns.	1	2	3	4	5	6	7
3. The virtual coach feedback increased my concentration.	1	2	3	4	5	6	7
4. The virtual coach feedback did not support my goals.	1	2	3	4	5	6	7
5. I was persuaded to follow the advice of the virtual coach.	1	2	3	4	5	6	7
6. I felt good about the virtual coach feedback	1	2	3	4	5	6	7
7. I didn't pay attention to the virtual coach feedback.	1	2	3	4	5	6	7
8. The virtual coach feedback helped me achieve my goals.	1	2	3	4	5	6	7
9. I was not receptive to the virtual coach feedback.	1	2	3	4	5	6	7
10. The virtual coach feedback was distracting.	1	2	3	4	5	6	7
11. I felt frustrated during the training.	1	2	3	4	5	6	7

	Strongly Disagree						Strongly Agree
12. I felt anxious about my performance during the training.	1	2	3	4	5	6	7
13. The virtual coach feedback eased my frustration with my performance during the training.	1	2	3	4	5	6	7
14. The virtual coach feedback calmed my anxiety when I made an error.	1	2	3	4	5	6	7
15. The virtual coach feedback made me believe I could do well during the training.	1	2	3	4	5	6	7
16. The virtual coach feedback made me feel optimistic when I made an error.	1	2	3	4	5	6	7
17. When the virtual coach prompted me to think critically, I was confident in my abilities.	1	2	3	4	5	6	7
18. The virtual coach feedback made me feel determined when I made an error.	1	2	3	4	5	6	7
19. The virtual coach made me feel self-conscious about making errors.	1	2	3	4	5	6	7
20. The virtual coach feedback was not reassuring during the training.	1	2	3	4	5	6	7
21. The virtual coach feedback was not reassuring during the training.	1	2	3	4	5	6	7
22. The virtual coach feedback made me feel embarrassed when I made an error.	1	2	3	4	5	6	7
23. The virtual coach feedback reduced my effort during the training.	1	2	3	4	5	6	7
24. I was discouraged, when the virtual coach asked me to think of other alternatives.	1	2	3	4	5	6	7

Thank you for your time and responses!

Interviews

The open-ended interview is a common technique used to gather subjective data. Unlike surveys, which follow a closed format, interviews can be used to reveal unanticipated research problems. They are most effective in eliciting information about user preferences, impressions and attitudes (Dix, Finlay, Abowd, & Beale, 2004, p. 348). Although questions are formulated prior to the interview, the open format allows researchers the flexibility to explore a variety of topics, or examine a single topic in detail.

I started the interview process with the intent to discover any errors that might have failed to be identified during integration testing. As such, initial questions were concerned with three main usability principles, which Dix and colleagues describe as learnability, flexibility, and robustness. Learnability is the ease at which new users can begin effective interaction. Flexibility is the existence of multiple ways in which the user and system exchange information. Robustness is the level of support provided in determining successful achievement of goals (p. 260).

Notes taken during each interview were transcribed daily and reviewed twice weekly. After no integration issues were found, special attention was given to the participants overall impressions of the VC. Interview questions began at a high-level and gradually progressed to inquiries about the participant's reaction to specific VC responses. Typical interview questions consisted of the following:

1. What were your impressions of the VC?
2. Did you ever feel frustrated or lost at any point during the training?
3. Did the VC help you refocus your efforts?
4. Were the VC recommendations helpful?
5. At any time during the training did the coach provide motivation by challenging you, or encouraging you with positive affirmations?

Data Analysis

Overview

This section will briefly describe the process used to analyze the data gathered from the various query techniques previously discussed. As the actual findings will be presented in the next chapter, the following discussion will emphasize the method and rationale used during data analysis. The following discussion illustrates the exploratory nature of the experiment.

During the two week controlled experiment research data was labeled and transferred to storage disk daily. This required all interview notes to be transcribed and all survey data to be retrieved from the test systems. Transcriptions were reviewed for common patterns during the middle and end of the week. Once a pattern was found among the transcripts, the raw data, consisting of performance and experiential data, was inspected for relationships that could be attributed to its causality. After the experiment concluded, a sample dataset was compiled consisting of the three quantitative measures collected: 1) quantity of errors, 2) quantities of engagement, and 3) quantities of self-efficacy.

The Statistical Package for the Social Sciences (SPSS) was then used to analyze the sample data. As indicated by Dix and colleagues, the guidelines for an ANOVA was used to determine the significance of any variations within the sample population. The objective was to find supporting evidence that would provide answers to my research questions, and guidelines for the development of a more robust instructional model. It was my hypothesis that a goal oriented model would increase student motivation and performance. A secondary goal was to analyze the data sample to determine relationships between types of errors, goal orientation, and feedback effectiveness.

Pre-conditions

This section describes the method of comparison for the actual dataset. The data will be presented in the form of mean averages. The mean is a nonresistant measure of spread, which suggests it is vulnerable to the influence of outliers. However, the mean remains a reliable measure when the sample remains homogeneous. All dependent variables in this experiment, with the exception of error rates, were within the scale of one to seven. This range was pre-established by the Likert scale used in the Post-Assessment Survey. Since the sample size for this experiment was relatively small, as some groups consisted of only two subjects, the mean can be considered equivalent to the median.

Due to the small size of the training groups, no reasonable comparisons could be made between them, therefore all comparisons were made at the collapsed System level. See APPENDIX D Table 23 for population summary and APPENDIX E for System subgroups. Since an ANOVA has been determined as the preferred method of analysis, following is a description of the main conditions which must be considered. The ANOVA pre-conditions provided the basic guidelines for actual data analysis.

The conditions for independent and dependent variables must be satisfied before an ANOVA can be used. The purpose of an ANOVA is to determine if groups have equal means within a population. A one-way ANOVA is used to compare an independent variable to the resulting outcome. An ANOVA requires an independent variable to have three or more levels. Independent variables can be described as factors influencing a specific outcome. In this experiment these factors consisted of multiple combinations of the four types of goal orientation, in addition to the VC version, which was used during training. Therefore, outcomes will be discussed in terms of the following four independent variables (see APPENDIX E):

1. Goal Orientation – Includes the four goal orientation combinations by VC version.
2. Mastery-Performance – Includes Mastery and Performance groups by VC version.
3. Valence – Levels include Approach and Avoidance orientation groups by VC version.
4. System – Levels include the two VC versions (BC and MEC).

The purpose of data analysis was to find associations between the four independent variables and VC evaluation results that would substantiate my hypothesis. As such, the results from Goal Orientation groups were compared between VC versions, in order to determine if there were differences in measures of engagement, self-efficacy, or performance. Similarly, Mastery-Performance and Valence groups were used to compare the VC's respective performance for measures of self-efficacy and engagement. Finally, the System group was used to judge which VC version performed best overall in any of the three measures of learning motivation.

In addition to independent variables, the conditions for dependent variables were also considered. The learning motivation evaluation criteria were used as the dependent variables in this experiment. Dependent variables must be of type interval or ratio to be used in an ANOVA (One-way ANOVA using SPSS). Since data collected using Likert scales were of type interval, the seven measures of engagement and self-efficacy satisfied this condition. Also, as the AVG Engagement, AVG Errors, and AVG Self-Efficacy were ratios, they also met the criteria. However, as Table 11 indicates, quantity of Fatal, Non-fatal, and Order errors did not satisfy the condition and therefore were excluded from analysis. However, they were used to make relational inferences.

Table 11 Independent Variables by Type

Type	Variable
Interval	Feeling Right
	Attention
	Persuasion
	Affect
	Confidence
	Regulation
	Effort
Ratio	AVG Engagement
	AVG Errors
	AVG Self-Efficacy
Ordinal	Fatal Errors
	Non-fatal Errors
	Order Errors

The following hypotheses were established to predict the resulting outcomes:

1. H_O: In the population, all orientation groups have equal mean scores.
2. H_A: In the population, inequality exists among orientation groups mean scores.

Prior to running an ANOVA, it must be determined that the following three assumptions for meaningful use have been met:

1. Independence between Groups: Samples are randomly selected and independent.
2. Normality: Scores are normally distributed around the mean.
3. Homogeneity of Variance: The groups have equal variance within the population.

All dependent variables were verified against the assumptions for meaningful use. The assumption of independence was satisfied for the dataset, as each group remained independent and was randomly selected from the population. In the event that any of the other two conditions failed, a non-parametric test was used. According to Dix and colleagues, although less powerful, non-parametric tests make fewer assumptions about the data and therefore less likely to obtain false results (Dix, Finlay, Abowd, & Beale, 2004, p. 333).

A series of descriptive statistics and tests were used to verify the remaining two assumptions. The Kolmogorov-Smirnov (K-S) and Levene's test was used respectively to verify assumptions of normality and homogeneity. Upon verification of all three conditions, a one-way ANOVA was used to test for any significant differences. In the event that all assumptions were not met, the alternative, non-parametric; Kruskal-Wallis (K-W) one-way ANOVA was used. However, since the independent System variable only had two levels (BC or MEC version), a Student's T-test (ST) was the preferred method of analysis. If the independent variables failed to satisfy assumptions of normality or homogeneity, the non-parametric Mann-Whitney U (M-WU) test was used instead (Independent T-Test using SPSS).

If a significant result was found a post-hoc test was also required to identify the corresponding groups. The Tukey post-hoc test was used to locate all groups with significant results. Post-hoc tests are used when there are more than two groups being analyzed. The Tukey test was chosen because it is a less conservative test, which should reveal statically significant variations when they exist. In addition the marginal means can be viewed to determine the actual means found significant for each group.

CHAPTER 5

FINDINGS AND DISCUSSION

Proceeding from the explanation of data collection methods through surveys, interviews, and transcriptions, this chapter will present a detailed discussion of the research findings. As all procedures and rationale have been detailed previously, this chapter will focus on reporting the actual results. Where appropriate, the experimental results will be discussed in terms of their underlying cognitive theories.

The initial discussion will provide a summary of the sample results, in terms of the two remaining pre-conditions for an ANOVA. Next, three of the four independent variables identified as factors influencing quantitative measures of VC performance will be discussed in terms of the expected outcomes. The three variables discussed are as follows 1) Mastery-Performance, 2) Valence, and 3) System. The Goal Orientation component has been omitted as it consists of a combination of the other three groups. The discussion will provide a comparative analysis of design features, cognitive theory, interview transcripts, and error (Fatal, Non-fatal, and Order) quantities. This analysis will provide a description of the main problems inherent within the design of the VC. Therefore, the objective is not only to determine significant differences between sample groups, but to present the findings as generalizable results.

The value of these findings is in their ability to provide a baseline for future evaluation and indicators of relationships essential to the formation of a more robust instructional model. As Narciss and Huth explain, the mode of feedback presentation should be "considered separately and interactively with learner characteristics and instructional variables" (Shute, p.

176). Therefore, an effort has been made to emphasize results that provide evidence of this relationship.

Analysis of Dependent Variables

Analysis of Normality

Descriptive statistics and a K-S test were used to determine if the assumption of normality had been met by all dependent variables. All means appeared to be within close proximity to the medians and the skewness did not appear problematic. Thus the results of the K-S test were reviewed to determine if the significance value exceeded the 5% margin of error, which would disprove the null hypothesis. As Table 12 shows, this was true for the following five dependent variables: 1) Feeling Right, 2) Attention, 3) AVG Engagement, 4) Affect, and 5) AVG Self-Efficacy.

Table 12 Dependent Variables Test of Normality

Dependent Variables	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Feeling Right	.122	40	.138	.970	40	.364
Attention	.126	40	.108	.955	40	.110
Persuasion	.152	40	.021	.916	40	.006
AVG Engagement	.094	40	.200*	.978	40	.626
Affect	.111	40	.200*	.971	40	.382
Confidence	.161	40	.010	.955	40	.110
Regulation	.144	40	.035	.921	40	.008
Effort	.152	40	.021	.941	40	.037
AVG Self-Efficacy	.102	40	.200*	.977	40	.589
AVG Errors	.215	40	.000	.856	40	.000

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Therefore, since the remaining five dependent variables consisted of an unknown distribution, they required the non-parametric K-W One-Way ANOVA (Kruskal-Wallis H Test using SPSS).

ANOVA Results

Analysis of Homogeneity

In order to test for the assumption of homogeneity in the five normally distributed variables, a series of tests were used. Levene's test was used to judge whether the assumption of homogeneity of variance was met. As Table 13 shows, the significance values for the dependent variables were greater than 5% for all sample groups, which indicates the variance across the sample population is equal.

Table 13 Summarized Results of Levene's Test By Group

Levene's Test Normal Distribution		Feeling Right	Attention	AVG Engagement	Affect	AVG Self-Efficacy
Goal Orientation	Sig.	0.492	0.170	0.197	0.599	0.515
Mastery-Performance	Sig.	0.168	0.116	0.083	0.829	0.310
Valence	Sig.	0.617	0.556	0.584	0.888	0.958
System	Sig.	0.231	0.531	0.182	0.538	0.719

Thus, the assumption of homogeneity of variance was accepted (Levene's test, 2010). Since all three assumptions were satisfied, an ANOVA was confirmed as an adequate method of statistical analysis. See APPENDIX F for detailed results of Levene's Test for equality of error variance by group.

One-Way ANOVA

An ANOVA was used to determine if any significant differences existed among the normally distributed variables. As Table 14 shows, the significance values for all five dependent variables were outside the 5% margin of error for all groups.

Table 14 Summarized ANOVA Results by Group

One-Way ANOVA Normal Distribution		Feeling Right	Attention	AVG Engagement	Affect	AVG Self-Efficacy
Goal Orientation	Sig.	0.982	0.969	0.997	0.505	0.627
Mastery-Performance	Sig.	0.934	0.734	0.982	0.828	0.463
Valence	Sig.	0.942	0.840	0.962	0.635	0.371

Thus, it was concluded that there were no statistically significant difference between mean scores. Therefore, the null hypothesis was accepted. See APPENDIX G for detailed One-Way ANOVA results by group.

K-W One-Way ANOVA

The K-W One-Way ANOVA was used to determine if any statistically significant differences existed among the five variables with an unknown distribution. However, Table 15 shows the significance values for all five dependent variables were outside the 5% margin of error for all groups.

Table 15 Summarized K-W ANOVA by Group

K-W ANOVA Unknown Distribution		Persuasion	Confidence	Regulation	Effort	AVG Errors
Goal Orientation	Asymp. Sig.	0.616	0.730	0.369	0.672	0.764
Mastery-Performance	Asymp. Sig.	0.681	0.421	0.503	0.795	0.854
Valence	Asymp. Sig.	0.648	0.564	0.089	0.466	0.442

It was concluded that there were no statistically significant differences between mean scores. Therefore, the null hypothesis was accepted. See APPENDIX G for detailed K-W One-Way ANOVA results and means ranks by group.

Student T-Test Results

Analysis of Homogeneity and Student's T-Test

Levene's test for equality of variance was combined with the Student's T-test for System comparisons. If the significance value of Levene's test was greater than 5%, the variances were equal. As Table 13 and Table 16 show, the significance values, with the exception of Persuasion, were greater than 5%. However, the significance value for equal and unequal variance was the same for Persuasion.

Table 16 Levene's Test of Error Variances by System

Levene's Test Unknown Distribution Student's T-Test		**Persuasion**	**Confidence**	**Regulation**	**Effort**	**AVG Errors**
System	Sig.	0.046	0.295	0.478	0.255	0.139

As the results of Table 17 indicate, no statistically significant differences were found in scores between VC versions. See APPENDIX H for detailed Student's T-Test results.

Table 17 Student's T-Test by System

Student's T-Test Normal/Unknown Distribution	System Sig. (2-tailed)
Feeling Right	0.952
Attention	0.383
AVG Engagement	0.782
Affect	0.892
AVG Self-Efficacy	0.426
Persuasion	0.837
Confidence	0.367
Regulation	0.724
Effort	0.312
AVG Errors	0.444

Discussion

Mastery-Performance

As self-efficacy was a central design feature of the MEC, it was expected that it would outperform the BC on all quantitative measures of self-efficacy. The system was designed to provide a customized learning environment, based primarily on the learner's goal orientation. Its main objective was to reinforce adaptive behavioral patterns and mitigate maladaptive patterns. Goal setting feedback (APPENDIX B) was the primary method for achieving this purpose. Thus, the presentation of CQ and ES statements to mastery and performance oriented learners, respectively, was an essential part of this strategy.

ES statements were designed to diminish "obsessive worry about goal attainment" that could potentially overwhelm learners with performance goals (Dweck C. , p. 1042). In contrast, CQ statements were designed to increase the effort of learners with mastery goals, which according to Dweck, leads to improved performance during task difficulty (Dweck C. , p. 1042).

So, if the MEC was designed to deliver such customized responses, why were no statistically significant differences found between VC versions?

The Expanded MEC Instructional Model (Table 10) reveals clues to a fundamental design flaw within both VC versions. According to Bandura, success raises “mastery expectations; while repeated failure lower[s] them, particularly if…early in the course of events” (Bandura, 1977, p. 195). During the initial design, repeated steps were considered the most threatening activity in the VBT. This was accounted for by the delivery of CQ and ES statements upon Fatal errors, which required participants to repeat the previous step. However, on Order errors, the VC was constrained to a try-again static response. It was not considered by the development team that Order errors would be the most common errors made in an unknown domain. As Figure 5 shows, Fatal errors accounted for only 3% of the total amount of errors committed. As try-again responses were presented to participants repeatedly on both versions, the lack of additional assistance lowered their self-efficacy and overall engagement.

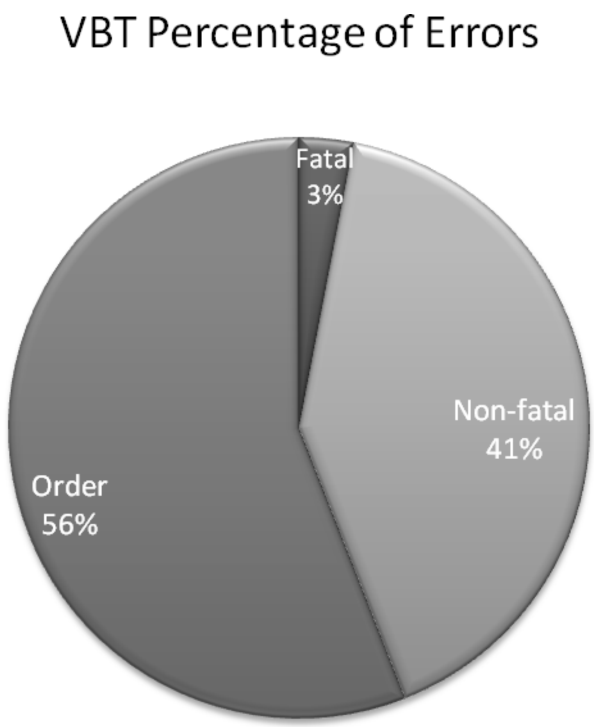

Figure 5 Combined VC Versions Percentage of Errors

The majority of the participants found the VC response on Order errors insufficient. As Bandura explains, attempts to "raise…expectations…without arranging conditions to facilitate effective performance will most likely lead to failures that discredit the persuaders and further undermine the recipients' perceived self-efficacy" (Bandura, 1977, p. 198). Thus, participants felt negative affect as a result of the inadequate assistance provided by the VC on Order errors. The following excerpt from interview transcripts provides some insight into this problem:

Researcher: Did you feel frustrated at anytime during the training?

Participant: I was frustrated when I kept getting the response this is not the correct time for this step. When I make an error [order errors] the VC should tell me what step I should be thinking about in the BNI.

Valence

As persuasion was another design feature of the MEC, it was expected to outperform the BC on all quantitative measures of engagement. Feedback was designed to be more persuasive, in order to make learners more receptive to correction. Regulatory fit techniques were used to frame corrective feedback in terms of the learner's goal orientation. This strategy was used to make the feedback more appealing and convincing to participants. Thus, the presentation of PS and AS statements to eager and vigilant learners, respectively, was an essential part of this strategy.

According to Elliot and colleagues, competence can be viewed in terms of an individual's ability to achieve positive or avoid negative outcomes (Elliot & McGregor, 2001, p. 502). Since this predisposition has also been attributed to triggering adaptive and maladaptive behavioral patterns, regulatory fit techniques were used to counter these effects. PS and AS statements were designed to be congruent with the attitudes of eager and vigilant learners, respectively. As Cesario and colleagues indicate "if the preferred means of goal pursuit are used, they [participants]…will engage more strongly in the goal-pursuit activity" (Cesario, Higgins, & Scholer, 2007, p. 446). If this method was employed, then why were no statistically significant differences found between VC versions?

Cesario and colleagues provides a logical explanation to the lack of significant results. They suggest that if the message is not congruent with the learner's natural disposition, they will experience a negative reaction (nonfit), which will decrease message persuasiveness (Cesario, Higgins, & Scholer, 2007, p. 447). As pre-assessment scores reveal, six participants from the MEC experimental group, had equal scores for multiple orientations. In the event of equal approach and avoidance scores, the participant was automatically categorized as a vigilant learner. Therefore, avoidance responses were delivered in the event that no dominant valence emerged. Similarly, if the mastery and performance scores were equal, the participant was categorized as a performance learner. However, if the learner's profile was not congruent with his actual orientation, then a nonfit condition may have occurred.

A Student's T-test was used to test the accuracy of the participant's orientation profile in the Non-video group. The independent variable was divided in terms of participants who displayed a dominant orientation and those who displayed a neutral orientation. Although four MAvoid and two PAvoid participants in the MEC experimental group displayed a neutral orientation, only the PAvoid group had a corresponding Dominant group. Therefore, the results are only applicable to PAvoid participants. As Table 18 shows, Levene's test confirms equal variance for all variables, except Regulation. In addition, the T-Test reveals a significant finding for the dependent variable Effort.

Table 18 MEC Student T-Test Dominant vs. Neutral Groups

Student's T-Test Normal/Unknown Distribution	Levene's Test for Equality of Variances	T-Test for Equality of Means
	Sig.	Sig. (2-tailed)
Feeling Right	.201	0.299
Attention	.285	0.093
AVG Engagement	.599	0.659
Affect	.315	0.428
AVG Self-Efficacy	.411	0.392
Persuasion	.460	0.137
Confidence	.931	0.741
Regulation	.031	0.474
Effort	.116	0.004
AVG Errors	.590	0.214

Therefore, as Table 19 shows, there is some difference among mean scores and there is less than a 5% probability that the results were obtained by chance. Thus, the null hypothesis was rejected. This experiment found that participants with a neutral orientation had a statistically significant lower rating of the MEC's ability to increase effort (4) than participants with a dominant orientation (5.125) (t(4)=6, P=0.004).

Table 19 MEC Dominant vs. Neutral Group Statics

	Neutral Dominant Group	N	Mean	Std. Deviation	Std. Error Mean
Effort	PAvoid Dominant	4	5.125	.2500	.1250
	PAvoid Neutral	2	4.000	.0000	.0000

System

I have discussed possible problems within both the Mastery-Performance and Valence groups, however, now I will examine problems within the system's overall design. Despite the problems previously discussed, it was still expected that the MEC would still outperform the BC in terms of quantitative measures of self-efficacy and engagement. As Bandura indicates; "the more extensive the performance aids, the more likely achievement will be attributed to the mediating artifact" (Bandura, 1977, p. 201). Therefore, only general guidance in the form of AS and PS statements were provided in the event of Non-fatal and Fatal errors. Excessive praise was not used by the MEC, as Dweck asserts, repetitive praise for easy tasks does not promote confidence or persistence during difficult situations (Dweck C. , 1986, p. 1045).

Elliott and Dweck demonstrated that learners induced towards learning goals choose more challenging tasks and display adaptive behavioral patterns (Dweck C. , 1988, p. 259). However, the MEC did not attempt to re-orient learners to the value of the BNI principles, but instead worked within the learner's predisposition towards performance or mastery goals. However, as Dweck indicates, within the performance framework, ability is dependent on the learner's level of confidence (Dweck C. , 1986, p. 1043). Therefore, confidence must remain high if a performance oriented learner is expected to remain effective during challenging tasks. In contrast, mastery oriented learners are more receptive to challenging tasks, where value is determined by the level of effort exerted (Dweck C. , 1986, p. 1042). So if the MEC was designed to support both frameworks, why were no statistically significant results found?

Dweck's proposed description of the mastery-performance dichotomy provides some guidance to a potential design flaw within the MEC. By analyzing the Expanded MEC Instructional Model (Table 10) in reference to Dweck's observed behavioral pattern, we see that CQ and ES statements were only delivered on Fatal errors. If Fatal errors had been the most common type of error made by participants, feedback may have been more effective in increasing Effort. See Figure 5 above for more details. The following excerpt from my interview transcripts reveal a trend in which participants did not receive any goal setting feedback during their training experience:

> **Researcher**: At any time during the training did the coach provide motivation by challenging you, or encouraging you with positive affirmations?
>
> **Participant**: I don’t remember any challenge or encouragement; I only remember the virtual coach telling me this is not the correct time to ask this question.

In fact, the maximum number of Fatal errors committed by a single participant was three, but even this participant could not recall if any CQ or ES statements were received.

CHAPTER 6

CONCLUSION, GUIDELINES, AND FUTURE WORK

Conclusion

The results of this experiment highlight the importance of iterative design in application development. As this was the first preliminary evaluation of the VBT system, it revealed some key issues within the system's design. Initially, my research investigated how goal orientation should be used to reduce negative affect, and increase self-efficacy, engagement, and performance. Another research objective was to determine how the relationship between errors, goal orientation, and feedback can be used to create a more robust instructional model. However, the results of the experiment presented new questions, which were foundational to these broader questions. Before any substantial comparison could be made between VC versions, the following questions had to be resolved:

1. Do all learners have a dominant goal orientation?
2. What type of feedback is effective for neutral orientations?
3. How often should goal-oriented feedback be delivered, in order to have an effect?
4. How does the type and quantity of errors influence the effectiveness of feedback?
5. How does a learner's goal orientation influence the effectiveness of feedback?

Although the results of the experiment failed to show any statistically significant differences between the two approaches to adaptive instruction (experience level and goal orientation), it did provide answers to my secondary objectives. My secondary objective was to determine how goal orientation and errors influence the effectiveness of feedback types. It was my belief that the information collected would provide guidelines for the development of a robust instructional model.

The VBT was chosen as the environment in which to explore my research questions, as it had an existing framework, which could be easily customized for research purposes. However, the try again response on Order-errors, which was subsequently revealed as a design flaw, was an unforeseen constraint, which had unanticipated consequences for the results of the evaluation. However, this constraint did allow the opportunity to explore more fundamental issues within the system design that would not have been discovered otherwise.

As this research was exploratory in nature, it consisted of an initial literature review of the BNI protocol, AI techniques, ITS systems, feedback types, goal orientation, and learning theory. This research was necessary in order to familiarize myself with the domain, in addition to finding evidence to support or refute aspects of the design. As this is the first formal evaluation of the fully integrated VBT, it can also be considered a summative evaluation as well. As a result, the evaluation exposed four main issues within the design of the VBT.

The four factors revealed in the last chapter are so integrated within the VC response, that they may have influenced the evaluation results. The four factors include: 1) Order Error Effects, 2) Try-Again Effects, 3) Profile Validity and, 4) Fatal Error Effects. Order Error Effects refer to conflicting expectations with inadequate support, which causes a reduction in learner engagement. In contrast, Try-Again Effects refer to frustrations resulting from repetitive failure, which causes a reduction in learner self-efficacy. Profile Validity is the improper classification of participants, who identify equally with multiple goal orientations. Finally, Fatal Error Effects refer to the lack of incentive required for learners to persist with the task.

The combination of Order Error and Try-Again Effects caused participants to repeat category selections until correct. However, since the majority of errors committed were Order errors, participants felt frustrated and discouraged during the training. This negative affect experienced by participants on both VC versions contributed to lowered self-efficacy and engagement. Therefore, although no significant differences were found between VC versions for measures of Affect, the ability of goal orientation to reduce negative affect remains inconclusive.

The third factor, Profile Validity, may have improperly categorized some participant's goal orientation. In the MEC experimental group, six participants failed to display a dominant orientation, but instead scored equally in multiple orientation categories. If participants received customized instruction that was not congruent with their goals or methods of pursuit, participants could have experienced a negative reaction towards the MEC feedback. Therefore, participants may have been less persuaded and engaged by it. As Table 18 and Table 19 revealed, there was a statistically significant difference in the amount of effort the MEC was able to promote in participants with dominant and neutral orientations. This may explain why no significant differences were found between VC versions for other measures as well.

Fatal Error Effects were also a factor in participant's overall training experience. When working within a learner's perceived mastery-performance framework, regular incentives are required in order to sustain the participant's levels of effort and self-confidence. The MEC used goal setting statements (CQ and ES) for mastery and performance oriented learners, respectively. However, these statements were ineffective because they were triggered on Fatal errors, which were only committed 3% of the time. Without these statements learners failed to receive the proper incentive to persist with the task. Therefore, the MEC's ability to increase performance remains inconclusive from the results of this evaluation.

Guidelines

Although questions regarding the effectiveness of goal orientation still remain unanswered, important discoveries have been made in the way of standards and conventions. Despite the criticism that complex feedback holds little value add in terms of learning performance, excerpts from my interview transcripts contradict this. Participants requested more flexibility, detailed assistance, and motivational support. ITS systems, such as the VBT, effectively raise the expectations of the learner. In addition to satisfying the learner's educational needs, the design must also satisfy their expectations. Therefore, the design problem becomes one of balancing system complexity with learning effectiveness. I will present three basic guidelines to achieve this purpose, which will clarify my remaining research questions.

Profile Validity

Individual goal orientation may not map directly to one distinct learning style. As the results of my evaluation revealed, a number of participant's demonstrated an orientation neutral disposition. This is described as a tendency to identify with characteristics of multiple goal orientations. During these instances, the system must be able to account for these discrepancies. One such solution would be to extract additional information in an attempt to narrow down the appropriate orientation. This precaution would help prevent against the existence of a nonfit condition. In addition, in order to ensure that the results of the experiment are comparable, an equal number of participants should be obtained for each goal orientation. As shown in Table 20, five participants per orientation would provide an adequate sample size to make individual comparisons. Therefore, each participant should be tested prior to enrolling in the experiment to ensure an equal distribution.

Table 20 Recommended Sample Population Size

System	Learning Orientation	No. of Participants
BC	MAvoid	5
	MApproach	5
	PAvoid	5
	PApproach	5
MEC	MAvoid	5
	MApproach	5
	PAvoid	5
	PApproach	5

Context Appropriate Feedback

Additionally, this research explored the relationship between errors, learning orientation, and feedback effectiveness. As the evaluation shows, there is a definite connection between these three components. The quantity of errors committed by participants was a key indicator of misconceptions requiring further assistance. Quantity and type of errors are useful in determining the frequency and type of corrective feedback that should be provided. Goal orientation should be used to determine the appropriate type of goal setting feedback. Thus, the VC response should consist of both goal setting and corrective feedback to provide a context appropriate response. See Figure 6 below for details.

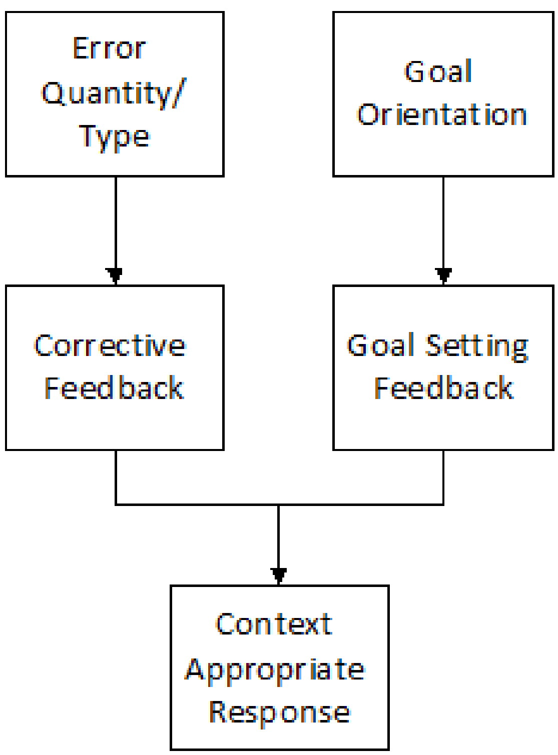

Figure 6 Context Appropriate Response

Feedback Consistency

As the VBT user population will consist of novice residents and experienced professionals, both levels of experience should be considered in the design. I do not advocate model-based remediation over re-teaching techniques, as research has proven them equally effective (Shute, 2008, p. 160). However, I do advise that an appropriate level of guidance be available for all types of errors. Thus, the try-again response on Order errors should be replaced with corrective feedback (APPENDIX B), which guides the participants to the appropriate BNI sequence.

Another factor in the design of the MEC is the concept of goal setting. In order to ensure that the learner remains engaged with the training, the VC must keep the learner focused on his individual goals. In order for this to be effective, the VC must possess customized goal setting methods, which are used regularly during training. As the appropriate contextual response is composed of corrective and goal setting feedback (APPENDIX B), they should be paired during all remediation attempts. Therefore, the Expanded MEC Instructional Model should be updated to include the modifications shown in Table 21 below.

Table 21 Updated MEC Instructional Model

Errors	Orientation	Feedback
Fatal	MAvoid	CQ +AS
	MApproach	CQ+PS
	PAvoid	ES+AS
	PApproach	ES+PS
Non-fatal	MAvoid	CQ +AS
	MApproach	CQ+PS
	PAvoid	ES+AS
	PApproach	ES+PS
Order	MAvoid	CQ +AS
	MApproach	CQ+PS
	PAvoid	ES+AS
	PApproach	ES+PS

Future Work

As the results of this evaluation illustrate, there are still improvements that can be made to the design of both VC versions. I have identified four factors within the current MEC design, which must be addressed before any statistically significant results can be determined between systems: 1) Order Error Effects, 2) Try-Again Effects, 3) Profile Validity, and 4) Fatal Error Effects.

The existence of these underlying issues made differences in VC performance virtually undetectable, as reflected in measures of self-efficacy and engagement. While learning performance, as measured by quantity of errors, was slightly higher on the MEC, it has not been included as a separate design issue, as it has been attributed to Order Error Effects. Therefore, these issues are expected to be resolved upon the implementation of the Updated MEC Instructional Model (Table 21). Although no significant results have been found for any of the dependent variables between versions, it can be noted that the MEC scored slightly higher than the BC for the majority of the measures of effectiveness, accept Feeling Right.

As Figure 7 shows, Affect, Regulation and AVG Self-Efficacy, were slightly higher in the Non-video group. Although the BC scored slightly higher in terms of Feeling Right, this difference is most likely the result of Order Error Effects, as opposed to any clear distinction in message congruence. However, the MEC was slightly more effective in terms of Affect, Regulation, and AVG Self-Efficacy. These results are consistent with findings indicating that participants in fit conditions, report “more positive attitudes toward the message topic” (Cesario & Higgins, 2008, p. 448). Therefore, these outcomes show positive indicators of increased MEC performance after further modification.

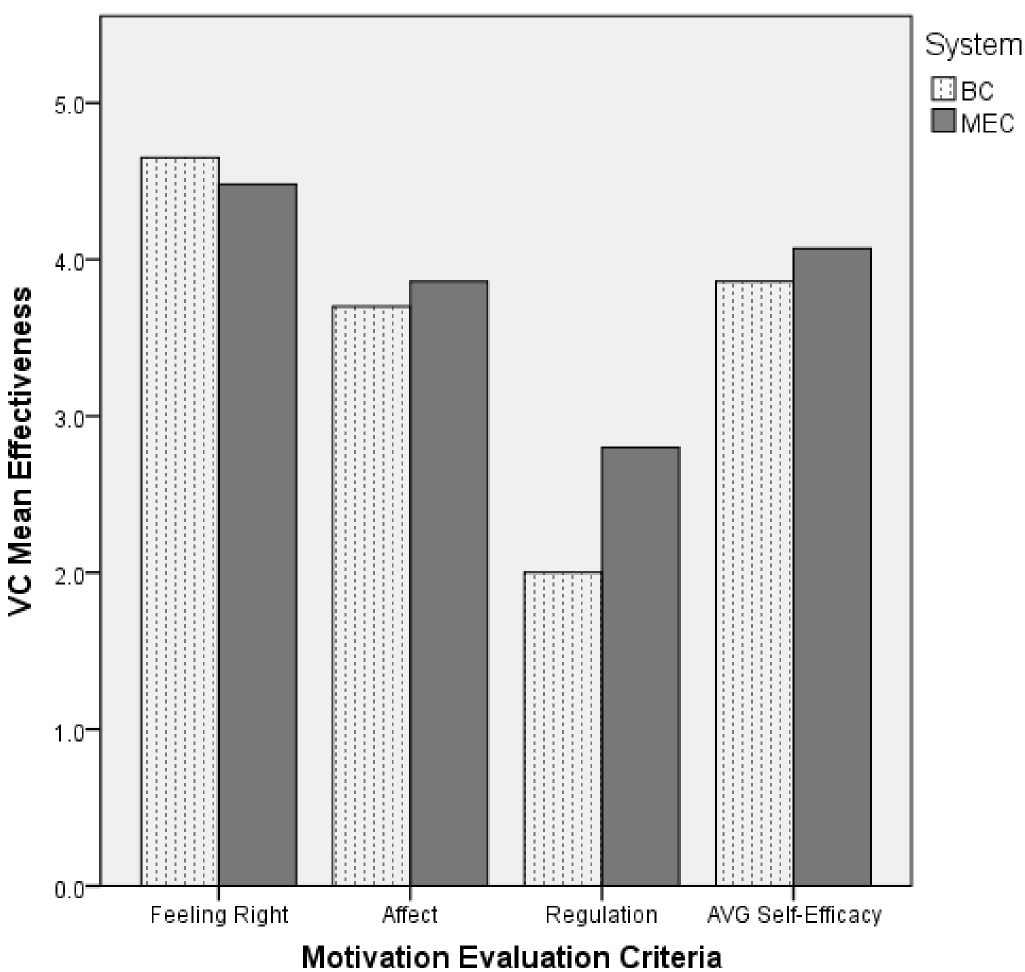

Figure 7 Non-video Measures of VC Effectiveness

However, the main area of future work consists of determining the most effective motivational strategies for participants with neutral orientations. Evaluation results confirmed the ability of the MEC to increase participant's effort, during difficult tasks, was significantly lower for participants with neutral orientations. Although not statistically significant, Figure 8 shows similar results for Feeling Right, Affect, and Confidence.

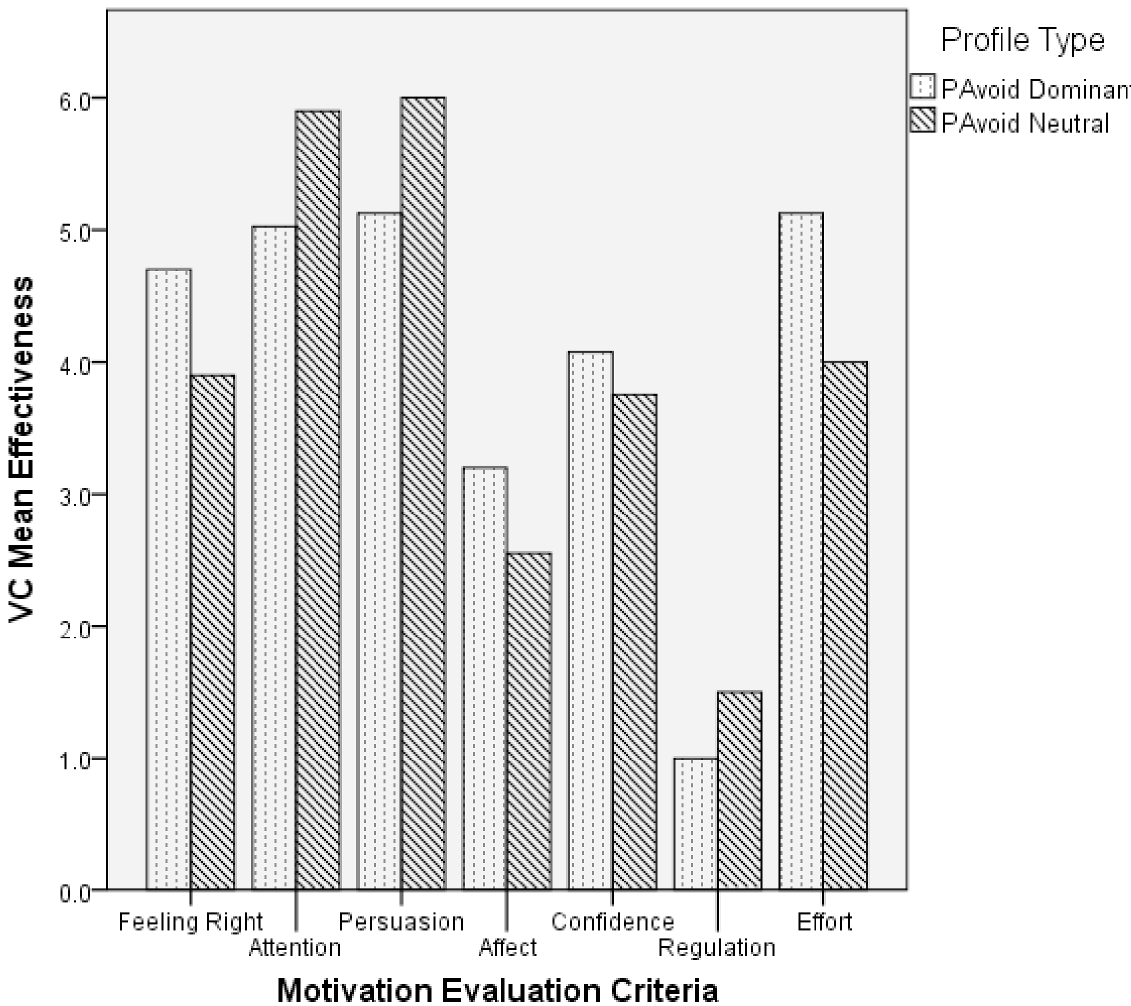

Figure 8 Measures of VC Effectiveness by Profile Type

At first glance the results of Figure 8 seem to confirm the instance of a nonfit condition within the Valence component. Low Feeling Right scores suggest that when the MEC was not in tune with neutral participant's method of goal pursuit, corresponding low scores resulted in measures of Affect and Confidence. However, further study seems to contradict this theory. As Attention and Persuasion measures remained relatively high for neutral participants, despite lower scores for all other measures of effectiveness.

These results suggest that Profile Validity may not have been the only factor influencing differences between groups. For example, high scores in measures of Attention and Persuasion indicate PS and AS statements were highly effective for neutral participants. However, low scores in measures of Feeling Right, Affect, and Confidence indicate instances when MEC feedback was not helpful, nor encouraging. As discussed previously, in order to promote persistence in performance oriented learners during difficult tasks, regular incentives are required to maintain their self-confidence. However, since CQ and AS statements were only delivered on Fatal errors, participants did not receive the proper incentive to sustain their effort. Therefore, it can be inferred that the problem was a combination of all four factors.

Further study is required to determine if a combination of goal setting and corrective feedback (APPENDIX B) can raise MEC effectiveness in the three measures previously mentioned, while maintaining high levels of Attention and Persuasion. Therefore, future work should consist of identifying effective feedback techniques for orientation neutral participants. This work may reveal even more complexity in learner goal orientations. For instance, one focus area is in ascertaining under which conditions specific goal orientations are triggered in neutral learners. If these conditions are known, the problem is reduced to identifying these individuals and applying the appropriate techniques.

APPENDIX A

VBT VERSION A DESIGN

Competencies and Criteria

Appendix A consists of the competencies (G) and criteria (F) used as global and local variable respectively in the knowledge trace production rules.

G1. Establish Rapport and Appropriate Relationship

a. Description: Scenarios that measure knowledge of establishing a friendly environment.
b. Examples:
    i. Introductions
    ii. Discuss patient's mood
    iii. Discuss patient's symptoms
c. Criteria:
    i. F1 – Avoid Arguing and Confrontation – Ability to avoid judgment and potential conflict.
    ii. F2 – Avoid Fatal Words
    iii. F3 – Set a Comfortable Climate – Express concern. Be supportive and understanding of patient's situation.
    iv. F4 – View Patient as Equal in discussion.

G2. Assess Patient/Situation – Ability to understand the current situation.

a. Description: Scenarios that measures the ability to provide accurate, relevant, medical advice, and supportive facts.
b. Examples:
    i. Discuss family history
    ii. Discuss medical history
    iii. Previous injury
    iv. Review screening
c. Criteria:
    i. F1 – Ability to modify the BNI to fit the situation – Choose the right path or emphasize a particular step.
    ii. F2 – Use Reflective Listening – Understanding patient's concerns and restating them to confirm understanding.
    iii. F3 – Ability to identify potential problem and motivational areas.

G3. Engage and Motivate Patient – Ability to motivate change in patient.

a. Description: Scenarios that measures knowledge of reduction techniques.
b. Examples:
    i. Ask about readiness to change

ii. Negotiate goals
iii. Give advice
iv. Summarize

c. Criteria:
i. F1 – Use reflective listening – Understanding patient's concerns and restating them to confirm understanding.
ii. F2 – Guide the patient to gain insight into his/her actions.
iii. F3 – Ability to boost motivation.

G4. Give Feedback to Patient – Ability to make the patient understand the current situation.

a. Description: Scenarios that measures ability to establish a connection.

b. Examples:
i. Ask About/Make a connection
ii. Apply Health Statistics
iii. Apply NIAAA Guidelines

c. Criteria:
i. F1 – Provide guidelines and risks appropriately – Guidelines can be over or under used.
ii. F2 – Make Connections – With drug use to life problems or ER visit.
iii. Appropriate Tone: Ability to avoid judgment and potential conflict.
iv. F3 – Use Reflective Listening – Ask open ended questions and summarize the patient's response.
v. F4 – Guide the patient to make insights on his/her own.

G5. Establish Action Plan

a. Description: Scenarios that measures knowledge of reduction techniques.

b. Examples:
i. Ask about readiness to change
ii. Negotiate goals
iii. Give advice
iv. Summarize

c. Criteria:
i. F1 – Negotiate an achievable goal – Plan should not be forced or assigned. The patient must want/agree with it.
ii. F2 – Appropriate Advise: Ability to provide accurate, relevant, medical advice, and supportive facts.
iii. F3 – Counter Resistance – Usually related to setting a defined goal.

NOTE: Each global competency focuses on either the current situation (now) or changing the current situation (future).

Fuzzy Set Logic Calculations

The following section details the fuzzy set logic calculation used to generate the learner's experience level.

Step 1: Define Performance Condition

a. Note: Each Global Variable (G_k) and Local Variable (F_k) will generate a performance distribution that determines the users knowledge state :
   i. NK – No Knowledge
   ii. LK – Limited Knowledge
   iii. UK – Unautomated Knowledge
   iv. PK – Partial Automated Knowledge
   v. FK – Fully Developed Knowledge

Step 2: Set an Initial Student Distribution: F= (NK, LK, UK, PK, FK)

a. Set the initial percentages for each performance condition.
b. Set an even Initial Distribution:
   i. F = (20, 20, 20, 20, 20)

Step 3: Set the Update rates for the performance conditions:

a. Note: Two factors determine the update rate assigned to a performance condition for a local variable.
   i. The condition's strength as an indicator of competency
   ii. The frequency with which the action associated with the condition might occur during any given problem-solving session
b. Set the range vector (v).
   i. The Range Vector (v) is the weighted distribution of the quality of the student's response. A percentage value assigned to the performance conditions, based on the quality of the student's response.
   ii. Example Ranges:
      1. Moderate Range Vector [v= (0, 30, 100, 100, 100)], [v=(100, 100, 90, 60, 0)]
         a. Assigns values to performance conditions.
      2. Description: If the student gets a question right and the system determines the student has NK, the performance is multiplied by a weighted vector (v) of 100 **%,** if they have LK, v = 100%. If they have UK, v=90%, PK v=60%, or FK, v = 0%.
c. Set Percentage Rate of Change (c):
   i. The Percentage Rate of Change (c) determines how fast the knowledge states will begin to converge to one state.
   ii. Example Rates:
      1. Moderate rate of change (c = 10%), which slowly changes the performance values.

Step 4: Establish Global Variable (G_k) – Global Variables are the competencies you are testing. See Competencies and Criteria section above for more details.

Step 5: Establish Local Variable (F_k) – The local variables are more specific actions indicating how (g_k) is completed. See Competencies and Criteria section above.

Step 6: Set the weight for the Local Variable (F_k) to determine each global variable (G_k).

a. Note: Set the weight based on the importance of the local variables (F_k) in relation to (G_k). Total should add to 100%.
b. Example Weights: $w = (w_1, w_2, w_3)$, $w = (.6, .2, .2)$
c. Sample Weights
    i. G_1- Establish Rapport
        a. F_1 – Appropriate Tone (.6)
        b. F_2 – Use Reflective Listening (.2)
        c. F_3 – Accuracy of Response (.2)

Step 7: Calculate Upgrade for all local variable ($F_1...F_3$)

a. Note: Upgrade calculations are performed for each correct response
    i. $f_1 = f_1 - f_1v_1c$, for first distribution , or performance condition in f_1 only
    ii. $f_i = f_i - f_iv_ic + f_{i-1}v_{i-1}c$, for second to fifth distribution , or performance condition in $f_{2..5}$ only, $v_5=0$ where $i=2…5$
    iii. Result Set:
        1. $F_k = (f_1 , f_2, f_3, f_4, f_5)$, repeat for $F_1..F_3$

Step 8: Downgrade for each local variable.

a. Note: Downgrade calculations are performed for each incorrect response
    i. $F_i = f_I - f_iv_ic + f_{i+1}v_{i+1}c$, for $f_{1..4}$ only, $v_1 = 0$, $i=1….4$
    ii. $F_5 = f_5 - f_5v_5c$, for f_5 only
    iii. Results Set:
        1. $F_k = (f_1, f_2, f_3, f_4, f_5)$, repeat for $F_1..F_3$

Step 9: Calculate the knowledge distribution for (g_1) from ($F_1..F_3$):

a. From previous results:
    i. $F_1 = (f_{11} , f_{12}, f_{13}, f_{14}, f_{15})$
    ii. $F_2 = (f_{21} , f_{22}, f_{23}, f_{24}, f_{25})$
    iii. $F_3 = (f_{31} , f_{32}, f_{33}, f_{34}, f_{35})$
b. $g_k = w_1f_{1k}+w_2f_{2k}+w_3f_{3k}$, where k is the position within the performance distribution.
    i. $g_1 = w_1f_{11}+w_2f_{21}+w_3f_{31}$
    ii. $g_2 = w_1f_{12}+w_2f_{22}+w_3f_{32}$
    iii. $g_3 = w_1f_{13}+w_2f_{23}+w_3f_{33}$
    iv. $g_4 = w_1f_{14}+w_2f_{24}+w_3f_{34}$
    v. $g_5 = w_1f_{15}+w_2f_{25}+w_3f_{35}$

Step 10: Calculate the performance distribution for the global competency (G_1)

a. $G_k = (g_1, g_2, g_3, g_4, g_5)$, repeat for $G_1...G_6$

BC Feedback/Knowledge Trace Flowchart

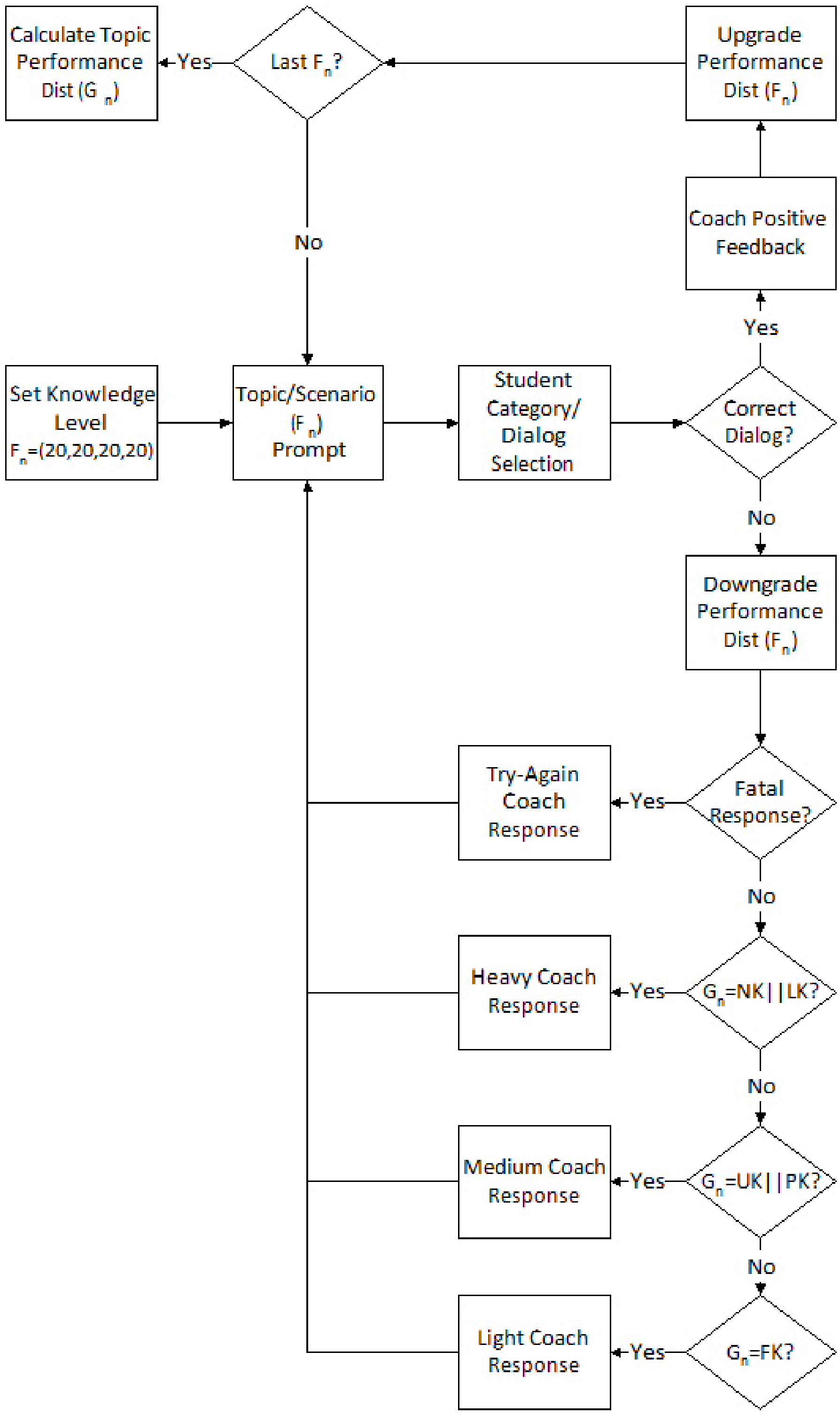

Figure 9 VBT Version A BC Feedback/Knowledge Trace Flowchart

APPENDIX B

VBT VERSION B DESIGN

MEC Feedback Construction

The MEC Feedback Construction provides a detailed description of the elements that comprise the MEC feedback response and rules for its assembly.

1. Dialog Authoring:
    a. Dialog Type:
        i. Goal Setting Feedback
            1. Challenge Questions (CQ)
            2. Encouragement Statements (ES)
        ii. Corrective Feedback
            1. Promotional Statements (PS)
            2. Avoidance Statements (AS)
    b. Dialog Rules:
        i. Dialogue should be authored for Fatal and Non-fatal errors.
            1. Prevention statements:
                a. [Lead in] to avoid [Action to avoid] in order to [Goal to Obtain].
            2. Promotion Statements:
                a. [Lead in] to[Action to pursue] in order to [Goal to Obtain]
            3. Note: A “Lead in” is just a statement such as, Remember, You will want to, You may want to.
2. MEC System Requirements
    a. Store/Retrieve the user orientation type (TAKE AVERAGE AND USE MAX VALUE).
    b. Feedback Construction rules for Fatal and Non-fatal Errors:
        i. Fatal Dialog: [ENCOURAGEMENT AND CHALLENGE]
            1. Performance Avoidance = Encouragement +Avoidance
            2. Performance Approach = Encouragement + Promotion
            3. Mastery Avoidance = Challenge +Avoidance
            4. Mastery Approach = Challenge + Promotion
        ii. Non-Fatal Dialog:
            1. Performance Avoidance = Avoidance
            2. Performance Approach = Promotion
            3. Mastery Avoidance = Avoidance
            4. Mastery Approach = Promotion

3. VC Gestures : Coordinate gestures with Avoidance or Promotional feedback
    a. Avoidance Coach – serious expression; back leaning body position, hand movement pushing downward in precautionary manner.
    b. Promotional Coach – enthusiastic expression; forward-leaning body position; hand movements openly projecting outward in (eager manner).

APPENDIX C

COMPONENTS OF THE BNI HANDOUT

The Components of the BNI Handout was provided to participants during the Non-video portion of the laboratory experiment as supplementary training material. It contains a description of the four main steps of the BNI protocol.

The BNI procedure consists of 4 major steps:

1. Raise the Subject
    - Establish rapport
    - Raise the subject of alcohol or drug use
    - Assess comfort

2. Provide Feedback
    - Review patient's alcohol/drug use and patterns
    - Make connection between alcohol/drug use and negative consequences in many areas of life including: medical, legal, family and employment
    - Make connection between alcohol/drug use and medical visit
    - Discuss issues related to physical dependence such as withdrawal and the need to continually use drugs

3. Enhance Motivation
    - Assess readiness to change
    - Boost motivation

4. Negotiate and Advise
    - Negotiate goal
    - Give advice
    - Summarize and complete referral/or alcohol/drug agreement

APPENDIX D

UN-COLLAPSED AND COLLAPSED SAMPLE POPULATION

Table 22 Un-collapsed Population by Training Group

Training	System	Learning Orientation	No. of Participants
Video	BC	MAvoid	3
		MApproach	4
		PAvoid	2
		PApproach	1
	MEC	MAvoid	2
		MApproach	3
		PAvoid	4
		PApproach	1
Non-video	BC	MAvoid	5
		MApproach	0
		PAvoid	4
		PApproach	1
	MEC	MAvoid	2
		MApproach	5
		PAvoid	2
		PApproach	1

Table 23 Collapsed Population by System

System	Learning Orientation	No. of Participants
BC	MAvoid	8
	MApproach	4
	PAvoid	6
	PApproach	2
MEC	MAvoid	4
	MApproach	8
	PAvoid	6
	PApproach	2

APPENDIX E

INDEPENDENT VARIABLES BY SYSTEM

Collapsed Independent Variables

Table 24 Goal Orientation Group

System	Levels
BC	MApproach
	MAvoid
	PApproach
	PAvoid
MEC	MApproach
	MAvoid
	PApproach
	PAvoid

Table 25 Mastery-Performance Group

System	Groups	Levels
BC	Mastery	MApproach
		MAvoid
	Performance	PApproach
		PAvoid
MEC	Mastery	MApproach
		MAvoid
	Performance	PApproach
		PAvoid

Table 26 Valence Group

System	Groups	Levels
BC	Approach	MApproach
		PApproach
	Avoid	MAvoid
		PAvoid
MEC	Approach	MApproach
		PApproach
	Avoid	MAvoid
		PAvoid

<u>Un-collapsed Independent Variables by Subgroup</u>

Table 27 Training Group

Subgroup	Training	Levels
Orientation	Video	Goal Orientation
	Non-video	Goal Orientation
Motivation	Video	Mastery-Performance
	Non-video	Mastery-Performance
Fit	Video	Valence
	Non-video	Valence
Version	Video	System
	Non-video	System

APPENDIX F

LEVENE'S TEST RESULTS BY GROUP

APPENDIX F consists of Levene's Test for homogeneity of variance. It tests the null hypothesis that the error variances of the dependent variables are equal across groups.

Table 28 Levene's Test by Goal Orientation

	F	df1	df2	Sig.
Feeling Right	.937	7	32	.492
Attention	1.603	7	32	.170
AVG Engagement	1.516	7	32	.197
Affect	.793	7	32	.599
AVG Self-Efficacy	.905	7	32	.515

Table 29 Levene's Test by Mastery-Performance

	F	df1	df2	Sig.
Feeling Right	1.782	3	36	.168
Attention	2.108	3	36	.116
AVG Engagement	2.408	3	36	.083
Affect	.295	3	36	.829
AVG Self-Efficacy	1.238	3	36	.310

Table 30 Levene's Test by Valence

	F	df1	df2	Sig.
Feeling Right	.604	3	36	.617
Attention	.703	3	36	.556
AVG Engagement	.657	3	36	.584
Affect	.211	3	36	.888
AVG Self-Efficacy	.102	3	36	.958

APPENDIX G

ANOVA RESULTS BY GROUP

One-Way ANOVA Results by Group

Table 31 ANOVA by Goal Orientation

		Sum of Squares	df	Mean Square	F	Sig.
Feeling Right	Between Groups	1.735	7	.248	.204	.982
	Within Groups	38.881	32	1.215		
	Total	40.616	39			
Attention	Between Groups	1.193	7	.170	.250	.969
	Within Groups	21.837	32	.682		
	Total	23.030	39			
AVG Engagement	Between Groups	.484	7	.069	.109	.997
	Within Groups	20.214	32	.632		
	Total	20.698	39			
Affect	Between Groups	8.552	7	1.222	.919	.505
	Within Groups	42.523	32	1.329		
	Total	51.075	39			
AVG Self-Efficacy	Between Groups	3.387	7	.484	.756	.627
	Within Groups	20.472	32	.640		
	Total	23.859	39			

Table 32 ANOVA by Mastery-Performance

		Sum of Squares	df	Mean Square	F	Sig.
Feeling Right	Between Groups	.477	3	.159	.143	.934
	Within Groups	40.139	36	1.115		
	Total	40.616	39			
Attention	Between Groups	.793	3	.264	.428	.734
	Within Groups	22.237	36	.618		
	Total	23.030	39			
AVG Engagement	Between Groups	.098	3	.033	.057	.982
	Within Groups	20.600	36	.572		
	Total	20.698	39			
Affect	Between Groups	1.229	3	.410	.296	.828
	Within Groups	49.846	36	1.385		
	Total	51.075	39			
AVG Self-Efficacy	Between Groups	1.621	3	.540	.875	.463
	Within Groups	22.238	36	.618		
	Total	23.859	39			

Table 33 ANOVA by Valence

		Sum of Squares	df	Mean Square	F	Sig.
Feeling Right	Between Groups	.434	3	.145	.129	.942
	Within Groups	40.182	36	1.116		
	Total	40.616	39			
Attention	Between Groups	.524	3	.175	.280	.840
	Within Groups	22.505	36	.625		
	Total	23.030	39			
AVG Engagement	Between Groups	.162	3	.054	.095	.962
	Within Groups	20.535	36	.570		
	Total	20.698	39			
Affect	Between Groups	2.339	3	.780	.576	.635
	Within Groups	48.736	36	1.354		
	Total	51.075	39			
AVG Self-Efficacy	Between Groups	1.965	3	.655	1.077	.371
	Within Groups	21.894	36	.608		
	Total	23.859	39			

K-W One-Way ANOVA Results by Group

Table 34 K-W One-Way ANOVA by Goal Orientation

	Persuasion	Confidence	Regulation	Effort	AVG Errors
Chi-Square	5.365	4.422	7.607	4.900	4.138
df	7	7	7	7	7
Asymp. Sig.	.616	.730	.369	.672	.764

Table 35 K-W One-Way ANOVA by Mastery Performance

	Persuasion	Confidence	Regulation	Effort	AVG Errors
Chi-Square	1.507	2.813	2.347	1.024	.783
df	3	3	3	3	3
Asymp. Sig.	.681	.421	.503	.795	.854

Table 36 K-W One-Way ANOVA by Valence

	Persuasion	Confidence	Regulation	Effort	AVG Errors
Chi-Square	1.652	2.043	6.519	2.549	2.690
df	3	3	3	3	3
Asymp. Sig.	.648	.564	.089	.466	.442

K-W One-Way ANOVA Means Ranks by Group

The Ranks table shows the mean rank of each dependent variable for each goal orientation and VC Version. If a significant difference is found, the Ranks Table is used to determine where the differences occurred.

Table 37 Mean Ranks by Goal Orientation

	Goal Orientation	N	Mean Rank
Persuasion	MApproach_BC	4	20.88
	MAvoid_BC	8	22.75
	PApproach_BC	2	8.00
	PAvoid_BC	6	23.17
	MApproach_MEC	8	20.00
	MAvoid_MEC	4	13.13
	PApproach_MEC	2	27.00
	PAvoid_MEC	6	22.17
	Total	40	
Confidence	MApproach_BC	4	15.38
	MAvoid_BC	8	23.00
	PApproach_BC	2	15.00
	PAvoid_BC	6	17.50
	MApproach_MEC	8	24.25
	MAvoid_MEC	4	25.75
	PApproach_MEC	2	22.00
	PAvoid_MEC	6	16.42
	Total	40	
Regulation	MApproach_BC	4	24.38
	MAvoid_BC	8	16.44
	PApproach_BC	2	30.25
	PAvoid_BC	6	20.75
	MApproach_MEC	8	26.19
	MAvoid_MEC	4	16.88
	PApproach_MEC	2	24.00
	PAvoid_MEC	6	13.50
	Total	40	

Table 36 (continued)

	Goal Orientation	N	Mean Rank
Effort	MApproach_BC	4	19.00
	MAvoid_BC	8	17.81
	PApproach_BC	2	29.50
	PAvoid_BC	6	16.83
	MApproach_MEC	8	22.69
	MAvoid_MEC	4	18.25
	PApproach_MEC	2	32.50
	PAvoid_MEC	6	20.33
	Total	40	
AVG Error	MApproach_BC	4	15.00
	MAvoid_BC	8	20.00
	PApproach_BC	2	15.00
	PAvoid_BC	6	23.50
	MApproach_MEC	8	20.50
	MAvoid_MEC	4	26.13
	PApproach_MEC	2	11.50
	PAvoid_MEC	6	22.92
	Total	40	

Table 38 Means Ranks by Mastery-Performance

	Mastery-Performance	N	Mean Rank
Persuasion	Mastery_BC	12	22.13
	Mastery_MEC	12	17.71
	Performance_BC	8	19.38
	Performance_MEC	8	23.38
	Total	40	
Confidence	Mastery_BC	12	20.46
	Mastery_MEC	12	24.75
	Performance_BC	8	16.88
	Performance_MEC	8	17.81
	Total	40	
Regulation	Mastery_BC	12	19.08
	Mastery_MEC	12	23.08
	Performance_BC	8	23.13
	Performance_MEC	8	16.13
	Total	40	
Effort	Mastery_BC	12	18.21
	Mastery_MEC	12	21.21
	Performance_BC	8	20.00
	Performance_MEC	8	23.38
	Total	40	
AVG Errors	Mastery_BC	12	18.33
	Mastery_MEC	12	22.38
	Performance_BC	8	21.38
	Performance_MEC	8	20.06
	Total	40	

Table 39 Means Ranks by Valence

	Valence	N	Mean Rank
Persuasion	Approach_BC	6	16.58
	Approach_MEC	10	21.40
	Avoid_BC	14	22.93
	Avoid_MEC	10	18.55
	Total	40	
Confidence	Approach_BC	6	15.25
	Approach_MEC	10	23.80
	Avoid_BC	14	20.64
	Avoid_MEC	10	20.15
	Total	40	
Regulation	Approach_BC	6	26.33
	Approach_MEC	10	25.75
	Avoid_BC	14	18.29
	Avoid_MEC	10	14.85
	Total	40	
Effort	Approach_BC	6	22.50
	Approach_MEC	10	24.65
	Avoid_BC	14	17.39
	Avoid_MEC	10	19.50
	Total	40	
AVG Errors	Approach_BC	6	15.00
	Approach_MEC	10	18.70
	Avoid_BC	14	21.50
	Avoid_MEC	10	24.20
	Total	40	

APPENDIX H

LEVENE'S AND STUDENT'S T-TEST RESULTS BY SYSTEM

Table 40 Levene and T-Test by Engagement Subgroups

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	Sig. (2-tailed)
Feeling Right	Equal variances assumed	1.481	0.231	.952
	Equal variances not assumed			.952
Attention	Equal variances assumed	0.400	0.531	.383
	Equal variances not assumed			.383
Persuasion	Equal variances assumed	4.267	0.046	.837
	Equal variances not assumed			.837
AVG Engagement	Equal variances assumed	1.844	0.182	.782
	Equal variances not assumed			.782

Table 41 Levene and T-Test by Self-Efficacy Subgroup

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	Sig. (2-tailed)
Affect	Equal variances assumed	.386	.538	.892
	Equal variances not assumed			.892
Confidence	Equal variances assumed	1.127	.295	.367
	Equal variances not assumed			.367
Regulation	Equal variances assumed	.514	.478	.724
	Equal variances not assumed			.724
Effort	Equal variances assumed	1.333	.255	.312
	Equal variances not assumed			.313
AVG Self-Efficacy	Equal variances assumed	.131	.719	.426
	Equal variances not assumed			.426

Table 42 Levene and T-Test by Performance

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	Sig. (2-tailed)
AVG Errors	Equal variances assumed	2.287	0.139	.444
	Equal variances not assumed			.445

Student's T-Test Group Statistics by System

The Group Statics table shows the measures of effectiveness for both VC versions. If any significant differences exist, the Group Statistics will show where these differences occurred.

Table 43 Levene and T-Test Group Statistics

	System	N	Mean	Std. Deviation	Std. Error Mean
Feeling Right	BC	20	4.530	1.1599	.2594
	MEC	20	4.550	.8900	.1990
Attention	BC	20	5.405	.7015	.1569
	MEC	20	5.190	.8341	.1865
Persuasion	BC	20	5.100	1.3534	.3026
	MEC	20	5.175	.8926	.1996
AVG Engagement	BC	20	4.975	.8328	.1862
	MEC	20	4.910	.6274	.1403
Affect	BC	20	3.600	1.2482	.2791
	MEC	20	3.650	1.0625	.2376
Confidence	BC	20	4.205	.9174	.2051
	MEC	20	4.455	.8108	.1813
Regulation	BC	20	1.900	1.3534	.3026
	MEC	20	2.075	1.7341	.3878
Effort	BC	20	4.450	1.4226	.3181
	MEC	20	4.850	1.0144	.2268
AVG Self-Efficacy	BC	20	3.645	.7763	.1736
	MEC	20	3.845	.7950	.1778
AVG Errors	BC	20	4.925	2.0063	.4486
	MEC	20	5.545	2.9740	.6650

APPENDIX I

RAW DATA

Table 44 Raw Data by Goal Orientation

Orientation	Sys.	Training	Fatal	Non-fatal	Order	AVG Errors	Feeling Right	Engage.	Pers.	AVG Engage.	Affect	Conf.	Reg.	Effort	AVG Self-Efficacy
MApproach	A	Video	0	5	6	3.7	6.3	6.3	6.5	6.3	4.5	5	3.5	5	4.6
MApproach	A	Video	1	5	3	3	4	5.3	5.5	4.8	1.8	2.8	1.5	4.5	2.5
MApproach	A	Video	0	7	6	4.3	2.5	4.8	2.5	3.4	4	3	2	5.5	3.6
MApproach	A	Video	0	7	8	5	5	4.5	5.5	4.9	3.3	4.5	2.5	3	3.5
MAvoid	A	Non-video	1	6	18	8.3	2.8	4.5	6	4.1	3	4.3	2	6	3.8
MAvoid	A	Non-video	1	8	21	10	5.3	6	6	5.7	5.5	5.8	0	6.5	4.8
MAvoid	A	Non-video	0	8	5	4.3	5	5.5	2.5	4.7	3.8	4.5	1.5	4.5	3.8
MAvoid	A	Non-video	1	5	10	5.3	5	5.5	5.5	5.3	3.5	4.8	5	3	4.1
MAvoid	A	Non-video	1	4	5	3.3	5.3	6.3	6	5.8	4.8	5.3	0	4	4

Table 43 (continued)

Orientation	Sys.	Training	Fatal	Non-fatal	Order	AVG Errors	Feeling Right	Engage.	Pers.	AVG Engage.	Affect	Conf.	Reg.	Effort	AVG Self-Efficacy
MAvoid	A	Video	0	7	5	4	3.5	5.8	6.5	5	1	2.5	0.5	1	1.4
MAvoid	A	Video	0	6	2	2.7	3.3	5	3	3.9	2.3	3.3	3	3	2.8
MAvoid	A	Video	1	6	5	4	6.5	5.8	6	6.1	5	5.3	0	5.5	4.3
PApproach	A	Non-video	0	7	5	4	4.5	5.3	4.5	4.8	1.5	3.5	2.5	6	3.1
PApproach	A	Video	0	7	5	4	5.5	5.8	3.5	5.2	3.8	4.5	3	5	4.1
PAvoid	A	Non-video	1	11	15	9	4.3	4	4	4.1	3.8	3.8	2.5	4.5	3.7
PAvoid	A	Non-video	1	6	9	5.3	3.3	5.3	6	4.6	3.8	3.3	1	4	3.2
PAvoid	A	Non-video	1	11	7	6.3	5.5	6.3	6.5	6	4.8	4.8	2.5	4.5	4.3
PAvoid	A	Non-video	0	7	7	4.7	5.5	6.5	6.5	6.1	2.5	4.3	3	6.5	3.8
PAvoid	A	Video	0	3	9	4	4.5	4.8	5	4.7	4.8	5	0	4.5	4
PAvoid	A	Video	0	5	5	3.3	3	4.8	4.5	4	4.5	3.8	2	2.5	3.5
MApproach	B	Non-video	1	10	22	11	3.8	5.8	4	4.6	3.8	3.8	2.5	4.5	3.7

Table 43 (continued)

Orientation	Sys.	Training	Fatal	Non-fatal	Order	AVG Errors	Feeling Right	Engage.	Pers.	AVG Engage.	Affect	Conf.	Reg.	Effort	AVG Self-Efficacy
MApproach	B	Non-video	0	6	7	4.3	5.5	6.3	6	5.9	5.3	5.8	2.5	5	4.9
MApproach	B	Non-video	0	8	10	6	3.3	4.5	4.5	4	4	3.5	1.5	3	3.3
MApproach	B	Non-video	1	8	7	5.3	5.8	5.5	4.5	5.4	2	4.8	4	6	3.9
MApproach	B	Non-video	1	6	11	6	5.3	5.8	6	5.6	5.3	5.5	6	6.5	5.7
MApproach	B	Video	0	6	5	3.7	4.8	3.3	6.5	4.5	3.3	4.8	5	6	4.5
MApproach	B	Video	0	5	2	2.3	5.5	5.8	5	5.5	3	4.8	2	4	3.6
MApproach	B	Video	0	4	5	3	4.5	3.8	5	4.3	2.5	4	0	4.5	2.9
MAvoid	B	Non-video	2	6	26	11.3	3	4	4.5	3.7	3.8	4.3	2	4.5	3.8
MAvoid	B	Non-video	3	8	25	12	5.5	6.3	6	5.9	4.3	5.3	4.5	5	4.8
MAvoid	B	Video	0	5	10	5	3.8	5	3.5	4.2	5.3	5.3	0	5.5	4.4
MAvoid	B	Video	0	2	3	1.7	5.3	5	4	4.9	3.5	4.3	0	2.5	3

Table 43 (continued)

Orientation	Sys.	Training	Fatal	Non-fatal	Order	AVG Errors	Feeling Right	Engage.	Pers.	AVG Engage.	Affect	Conf.	Reg.	Effort	AVG Self-Efficacy
PApproach	B	Non-video	0	6	6	4	4.8	5.3	5	5	5	4.8	2	6	4.6
PApproach	B	Video	0	5	5	3.3	3.5	5.5	6.5	4.9	4	4.3	2.5	5.5	4.1
PAvoid	B	Non-video	0	6	10	5.3	4	6	6.5	5.3	2.3	4.5	1.5	4	3.2
PAvoid	B	Non-video	1	11	13	8.3	3.8	5.8	5.5	4.9	2.8	3	1.5	4	2.8
PAvoid	B	Video	1	8	5	4.7	4.5	5.5	5	5	4.3	4.5	0	5.5	3.8
PAvoid	B	Video	0	6	14	6.7	4	4.3	4.5	4.2	2	2.5	1.5	5	2.6
PAvoid	B	Video	0	4	5	3	6	5	5.5	5.5	3.5	4.5	0	5	3.5
PAvoid	B	Video	0	7	5	4	4.3	5.3	5.5	4.9	3	4.8	2.5	5	3.8

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